MacGillivray Freeman's

National Parks Adventure

EDUCATOR GUIDE

TABLE OF CONTENTS

Introduction to guide

The *National Parks Adventure* Educator Guide, created by Science Museum of Minnesota for MacGillivray Freeman Films, is appropriate for students in the primary grades (K–8) and most useful when used as a companion to the film, but also valuable as a resource on its own. Teachers are strongly encouraged to adapt activities included in this guide to support specific state or national standards and the needs of their students. Activities developed for this guide support Next Generation Science Standards (NGSS). This guide focuses on the natural sciences highlighted by the film, but educators will find that *National Parks Adventure* features many other subjects as well—geography, history, and language arts all have strong tie-ins with the film. Teachers can find additional resources at the end of the guide to help with cross-curricular lesson planning.

The US National Park Service turns 100 years old in 2016, marking a major milestone in the preservation of America's pristine wild spaces. Today's National Park System includes more than 400 iconic landmarks —spectacularly beautiful places like Yellowstone, Yosemite, the Everglades, and Glacier National Parks— that represent the heritage and spirit of America and make a rich palette for a film for IMAX® and giant screen theatres. *National Parks Adventure*, narrated by Academy Award®-winner Robert Redford, brings the magnificence of these landscapes to the giant screen and introduces us to world-class mountaineer Conrad Anker, adventure photographer Max Lowe and artist Rachel Pohl as they hike, climb and explore their way across America's outdoor playgrounds. An action-packed celebration that will inspire the adventurer in everyone, *National Parks Adventure* highlights how important it is that we protect these treasured landscapes that belong to us all.

National Parks Adventure is a MacGillivray Freeman film produced in association with Brand USA. The film is presented globally by Expedia, Inc. and Subaru of America, Inc with major support from the Giant Dome Theater Consortium. *National Parks Adventure* is directed by Academy Award®-nominated filmmaker Greg MacGillivray and produced by Shaun MacGillivray. The film has a run time of 43 minutes. To learn more, visit www.nationalparksadventure.com.

Background

Changing Land, Changing Minds

The American frontier shrank throughout the 1800s. With the realization that our wilderness was both conquerable and rapidly diminishing, public attitudes towards the natural world shifted. Romantic artists and writers reimagined America's wilds, once a challenge to overcome and exploit, as places of sublime beauty, all the more valuable in their untouched state. A sense of nature's inherent value was growing.

Early preservationists—led by John Muir—and conservationists argued against the wanton waste of natural resources. Animal species teetered on the brink of extinction, and companies cut timber and mined minerals at an unsustainable rate. Conservationists advocated strategies to maximize economic benefits from the land over the long term. Preservationists believed we should preserve nature without considering future economic use. But they united to advocate for stronger government protection of publicly-held land.

> ***...We turn our rivers and streams into sewers and dumping-grounds, we pollute the air, we destroy forests, and exterminate fishes, birds and mammals . . . But at last it looks as if our people were awakening.***
>
> **—Theodore Roosevelt**

Mighty Foundations

It took several decades and the actions of many Presidents to build America's National Park System. In 1864, Abraham Lincoln granted federal land in Yosemite Valley to the State of California "for public use, resort and recreation," and to "be used and preserved for the benefit of mankind." Although California's government managed Yosemite at first, the idea behind Lincoln's words—that the government could maintain and protect wild and historic places for the enjoyment of all—would inform the creation of future national parks. (In 1906, Yosemite and the surrounding land were ceded back to the federal government.)

In 1872, President Ulysses S. Grant set aside almost 3,500 square miles of land stretching across the borders of Montana, Wyoming and Idaho, making Yellowstone the first official national park in the world. Three years later, Mackinac Island in Lake Huron became the second. (Mackinac later became Mackinac State Park—the first state park in Michigan.)

President Theodore Roosevelt's 1903 expedition to Yosemite with John Muir, recreated in *National Parks Adventure*, deepened his commitment to protecting America's remaining wild places. He signed laws creating five national parks and 18 national monuments. In all, Roosevelt set aside almost 360,000 square miles of federal land for preservation and conservation—more than all previous Presidents combined.

President Theodore Roosevelt, right, and preservationist
John Muir in Yosemite National Park, 1903.

We have fallen heirs to the most glorious heritage a people ever received, and each one must do his part if we wish to show that the nation is worthy of its good fortune.

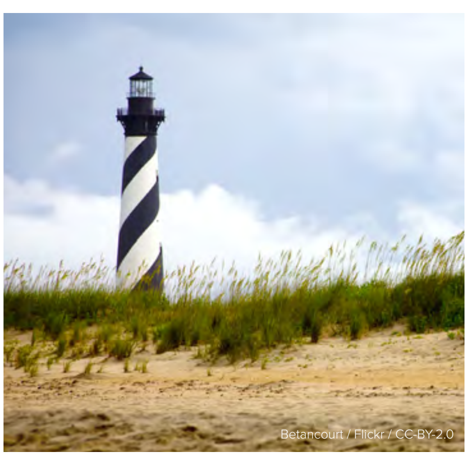
— Theodore Roosevelt

Forever Wild

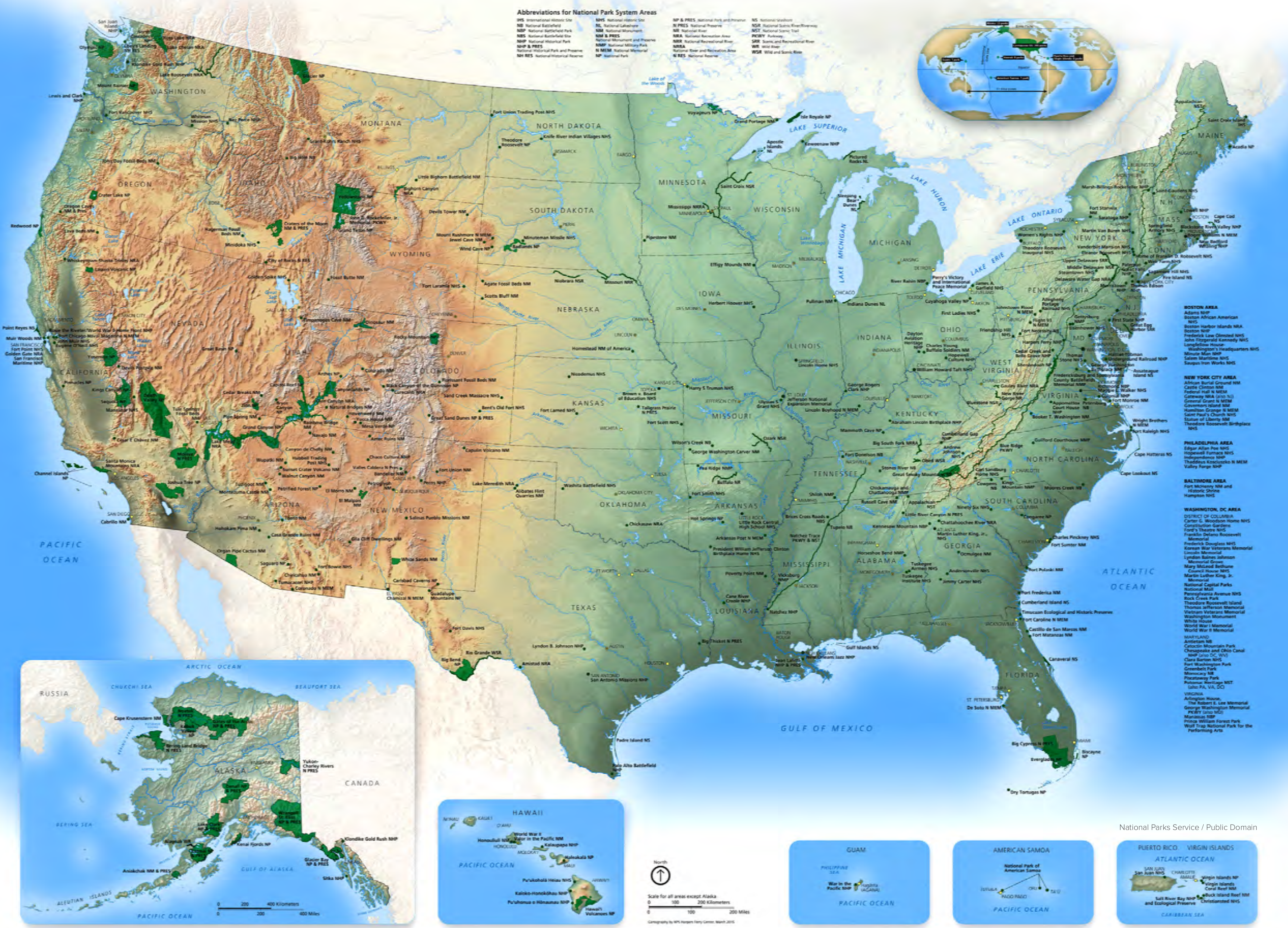
In 1916, President Woodrow Wilson created the National Park Service to manage the existing 35 national parks and monuments as well as any new ones. And the new agency's list of responsibilities grew quickly. In 1933, President Franklin Roosevelt transferred 56 national monuments and military sites from the Forest Service and War Department to the National Park Service, expanding the park system nationwide. The next year, in a radio address broadcast from Glacier National Park, the President echoed his distant cousin Theodore's belief in the importance of the national parks: "There is nothing so American as our national parks. The scenery and the wildlife are native. The fundamental idea behind the parks is native. It is, in brief, that the country belongs to the people, that it is…for the enrichment of the lives of all of us."

Today, the 84-million-acre National Park System includes the White House and more than 400 parks, monuments, battlefields, historic sites, lakeshores, seashores, recreation areas, rivers, and trails. National parks exist in every state, the District of Columbia, American Samoa, Guam, Puerto Rico, and the Virgin Islands. And protected areas range in size from the 13-million-acre Wrangell-St. Elias National Park and Preserve in Alaska to the Thaddeus Kosciuszko National Memorial, which occupies just 0.02 acres in Philadelphia, Pennsylvania. These places are the jewels of our national heritage—natural treasures set aside for and owned by everyone. National parks give nearly 300 million visitors each year the chance to find out that, in the words of John Muir, "…going to the mountains is going home; that wilderness is a necessity."

> ***America doesn't have the Louvre. We don't have Notre Dame. We don't have these spectacles of human building and art because we're such a new country. The National Parks give us a sense of foundation. . . .They root us in something that is forever.***
>
> **—Greg McGillivray, *National Parks Adventure* director**



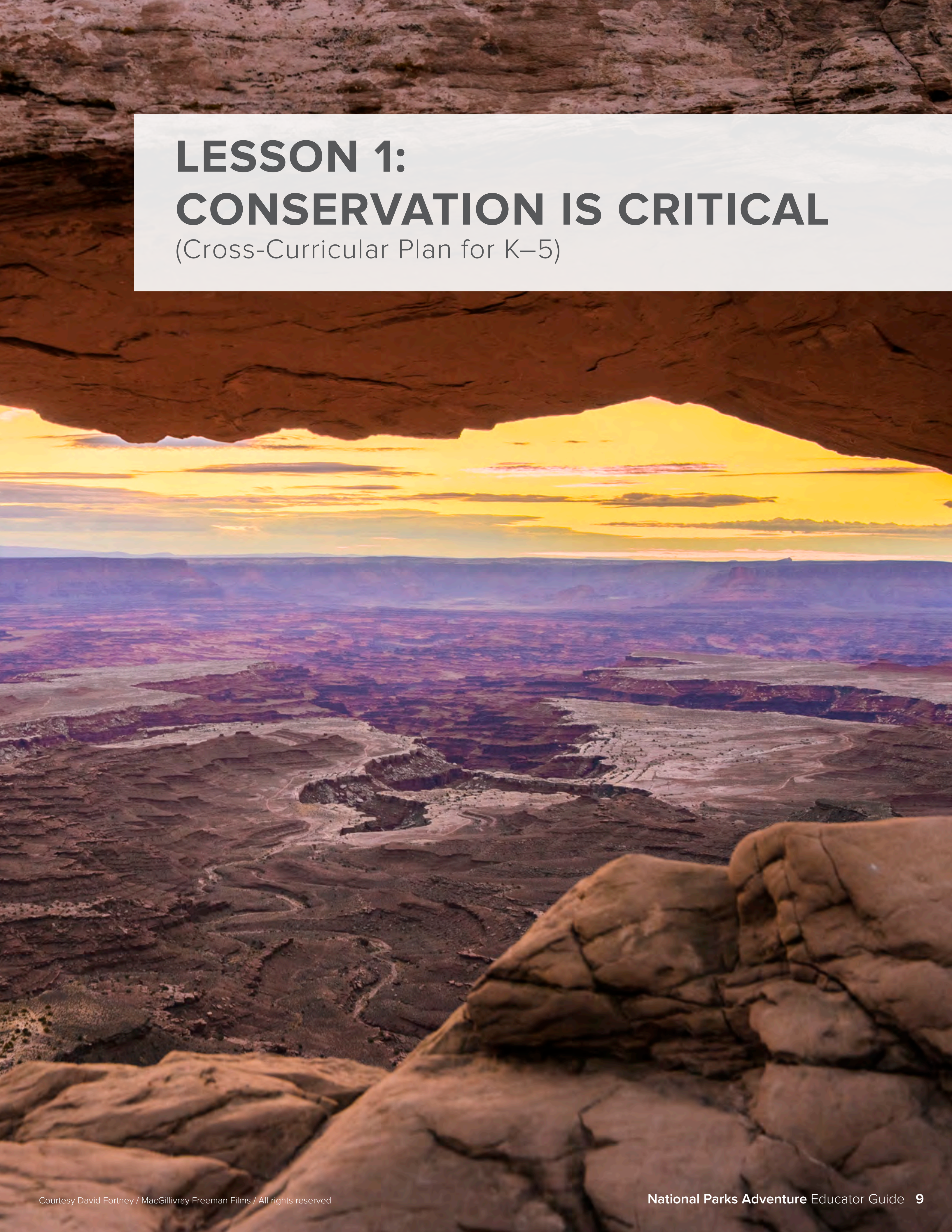
National parks map



National Parks Service / Public Domain

LESSON 1: CONSERVATION IS CRITICAL

(Cross-Curricular Plan for K–5)



Students are encouraged to think about how they can help conserve our natural spaces. This is a five-day, interdisciplinary lesson plan meant to build community in a K–5 school by having students explore and learn about the importance of conservation not only in our national parks, but around the world. While the plan is broken into two grade bands, K–2 and 3–5, the content and themes are the same throughout.

Grade Level(s): K–5

Lesson Length: 30–45 minutes per lesson; 5 lessons

NGSS alignment:
LS4.D Biodiversity and Humans
ESS3.C Human Impacts on Earth Systems
LS1.C Organization for Matter and Energy Flow in Organisms
ESS3.A Natural Resources
LS2.A Interdependent Relationships in Ecosystems
LS2.C Ecosystem Dynamics, Functioning, and Resilience

In the Film

In Redwood National Park, scientists are studying trees up to 300 feet tall and more than 3,000 years old. A thousand-mile expanse of giant trees like these once stretched from the Rocky Mountains to the Pacific coast. But 96% of this vast forest has been destroyed over the last 200 years. In the late 1800s, John Muir recognized the value of America's wild places, and worked to protect them from logging and illegal cattle grazing. Muir's writing fired the imagination of many influential people, including Presidents Ulysses Grant, Benjamin Harrison, and Theodore Roosevelt, who signed the laws creating America's first National Parks. Protected inside are the remaining stands of redwoods and sequoias and the animals that make their homes among them.

Key Words/Vocabulary (K–2)

Nature: The physical world and everything in it, including plants, animals, and landscapes, and the natural forces that control what happens in that world; anything not made by people

Protect: To defend or guard against loss or damage

Safe: Protected from hurt, danger, or risk

National Park: A scenic or historically important place protected by the US government for the enjoyment of visitors and the preservation of wildlife

Conservation: The protection of important and special things

Key Words/Vocabulary (3–5)

Conservation: The protection of important and special things

Resource: A place or thing that provides something useful

Nature: The physical world and everything in it, including plants, animals, and landscapes, and the natural forces that control what happens in that world; anything not made by people

Inference: A conclusion reached based on evidence and reasoning

Materials (K-2)

Day 1

☐ Pencils

☐ “What is Found in Nature?” student activity sheets

Day 2

☐ Pencils

☐ Crayons

☐ Scissors

☐ Stapler

☐ "Mini coloring book" handout (to print, choose "Short edge binding" in your printer options)

(decide before class if you or the students will staple the book together)

Day 3

☐ Pencils

☐ Watercolor paints

☐ Paintbrushes

☐ Watercolor or construction paper for painting

☐ Pictures of National Parks (find some examples on the Internet or in books)

Day 4

☐ Pencils

☐“Conservation Contract” student activity sheets

☐ Crayons, colored pencils, or markers

Day 5

☐ Pencils

☐ Glue

☐ Scissors

☐ Tape

☐ Construction paper (assorted colors)

☐ Crayons or markers

Materials (3-5)

Day 1

☐ Pencils

☐ Handout: Park Conservation Student Activity Sheet

☐ Student access to National Park information via printouts, books, or Internet

Day 2

☐ Pencils

☐ Handout: John Muir’s Favorite Things

Day 3

☐ Photos of John Muir

☐ Old nature magazines (if available)

☐ Construction paper (assorted colors)

☐ Markers, crayons, or colored pencils

☐ Scissors

☐ Glue sticks

☐ One cutout of John Muir per student

Day 4

☐ 11” x 17” white paper

☐ Markers, crayons, or colored pencils

☐ Scissors

☐ Glue sticks

Day 5

☐ Glue, staplers, or tape

☐ Handout: Yellowstone Act, 1872

Handout: Student-Created Park

(single, double-sided document)

☐ Handouts from previous days: John Muir “Cutout” from Day 3 and Park Conservation Student Activity Sheet

Teacher Prep Notes

K-2

For Day Three, students in grades 3–5 will be looking at photos of John Muir in nature and then creating an image of their own using collage materials. Find some photos of John Muir in nature before class to show the students.

3-5

On Day One, students in grades 3–5 will need information about some of the National Parks to fill out their Park Conservation Student Activity Sheet. You can provide this information, or have them do their own research. The National Parks website (nps.gov) allows you to find a park and learn more about it. Consider focusing on a specific region or a specific type of National Park. On Day Two, students in grades 3–5 will review photos of and quotes by John Muir. You may want to show a short biographical video or do a brief reading about his life before beginning this activity. Websites like sierraclub.org (select "John Muir Exhibit") and pbs.org (search for "National Parks") have many resources, including videos and articles.

> ***Any fool can destroy trees. They cannot run away; and if they could, they would still be destroyed—chased and hunted down as long as fun or a dollar could be got out of their bark hides, branching horns, or magnificent bole backbones. Few that fell trees plant them; nor would planting avail much towards getting back anything like the noble primeval forests. …Through all the wonderful, eventful centuries. . .God has cared for these trees, saved them from drought, disease, avalanches, and a thousand straining, leveling tempests and floods; but he cannot save them from fools—only Uncle Sam can do that.***
>
> **—John Muir**

Background

John Muir believed that as long as people could make money from trees, they'd continue to cut them down—even to the last tree. He also believed that, even if they planted new trees, loggers would never be able to repair the damage they caused to wild places. John Muir spent his life exposing people to nature and fighting for the preservation of nature itself. He and President Theodore Roosevelt agreed that wild places, with their power to inspire and heal, should be protected for the enjoyment of everyone. The shared vision of these two men led to the creation of our National Park System, which now includes more than 400 sites across the United States.

While protected in many ways, the parks are not completely immune from threats.

Invasive species are non-native plants or animals that negatively impact an ecosystem, often by outcompeting the native plants and animals and causing declines in their populations. America's National Parks currently contain more than 6,500 invasive species, and 70% of those are plants.

Air pollution from neighboring industries can cloud views, poison water, and kill plants.

Climate change over the past 30 years has caused a rise in temperatures, reducing snow and water levels and extending the fire season. These changes may force animals out of the parks and into unprotected areas.

The large number of people who visit America's National Parks each year stresses the ecosystems the Parks are meant to protect. Park managers must balance the needs of all species—including humans—when determining what activities should be permitted.

John Muir and Theodore Roosevelt worked together to create a National Park System that preserves natural and cultural resource for the enjoyment, education, and inspiration of this and future generations. So each generation has a duty to help preserve these national treasures. You can help!

If you find a non-native species, report it to a steward or ranger. Inspect your vehicles for invasive plants or animals that might find their way into protected areas.

To limit your personal contribution to air pollution, consider riding a bike or walking instead of driving when you can.

To help minimize the effects of climate change on an individual level, try to reduce your carbon footprint. There are lots of suggestions online. Bigger impacts, though, come from groups of concerned people working together. Pick an issue, learn about it, and write letters urging your elected officials or local utilities to act.

Follow the rules when visiting a National Park. Stay out of sensitive areas that could be destroyed by too much traffic. Respect the wildlife. Leave natural, historical, and archaeological items where you find them.

To Do (K-2)

Day 1

1. With the class, brainstorm about the types of things found in nature. This could be done as a large group discussion, think-pair-share, or a writing prompt.

2. Give a “What is Found in Nature?” activity sheet to each student. Have students draw or list things found in nature. Allow for independent work time.

3. Share findings and allow students to add to their activity sheets if they want to.

4. Closure: Ask students why nature is important. Do they know that National Parks protect special places?

Day 2

1. Read the mini coloring book aloud or together as a class.

2. As you read, ask questions like:

Why do you think John Muir cared so much?
Do you think a lot of people care about nature?
What are some ways you can care for nature?
Do you think today’s president should do anything special for nature like Teddy Roosevelt did?

3. When finished, each student should color her/his book and fill in the last page with something s/he can do at a National Park.

4. Closure: Have students share activities they could participate in at a park.

Day 3

1. Show pictures of National Parks from the National Parks website or have pictures from the Internet or books accessible.

2. Discuss with students what they see/observe. Begin a list of these ideas that students can refer to when selecting a scene to paint.

3. Explain that, like Rachel in the film, students will be painting something they could see in a National Park.

4. Have students paint using watercolors. It may be helpful for students to sketch in pencil first. Consider setting parameters, such as “include at least one landform and one animal.”

5. Encourage creativity!

Day 4

1. Have students share their paintings from Day 3 with the class. Discuss what the students painted and have students talk about what they learned through the previous activities. Why did President Roosevelt and John Muir work so hard to create protected wild places throughout our country? Then introduce the word conservation.

2. Have students think of something in nature they want to conserve/protect so it doesn't disappear. Who would they want to share with or show their plant/animal/landscape/etc. to someday? Pass out the conservation contract and help students fill in the blanks.

"I will help conserve ______ for _______ to see."

Have them sign their names at the bottom to make it official, then draw a self-portrait along with the plant/animal/landscape they chose to preserve and the person they chose to share it with.

3. Closure: If there is time, divide students into small groups and have them share their pictures. Brainstorm with students ideas for how to help conserve those things.

Day 5

1. Today students will select landforms, bodies of water, animals, or plants they would like to conserve, and create a mural on the outside of their classroom doors.

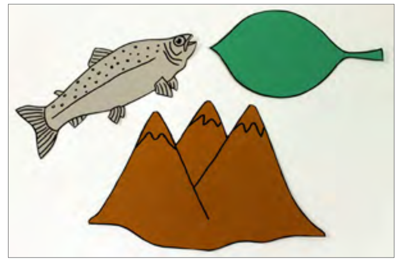
2. Some options for creating the door artwork:

Divide students into groups—landforms, bodies of water, animals, and plants—to ensure a variety of things for the door.

Create outlines of natural objects (a leaf, an animal, a landform, etc), cut them out, and have the students color them and write what they can do to conserve.

As a class, decide on one park to focus on and have each student create a piece of that park.

3. Later in the day or another day, walk with students around the school to see all of the different doors.

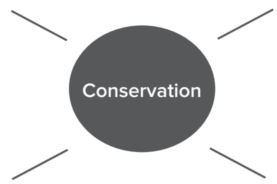


Examples of nature outlines

To Do (3-5)

Day 1

1. Begin by discussing the definition of conservation as a class. Draw a concept map like the following on the board



2. Brainstorm with the class about the words they associate with *conservation* and add them to the board. Students will likely come up with words like "protect," "nature," "animals," "plants," "parks," or "water."

3. Explain that students will now create their own concept map on their Park Conservation Student Activity Sheet by focusing on the conservation of one specific park. Hand out the Student Activity Sheet.

4. Have students learn about a specific park through print materials or online research, and generate a concept map of things in that park that should be conserved. (Younger students might prefer to create a list instead of a concept map.) Have older students look at conservation actions taken in the park, such as the addition of fences, paths, signage, etc..

5. Closure: have each student share one idea from his/her word cloud. Ask students to justify why we should help conserve their choices.

Day 2

1. As a class, briefly discuss John Muir and his career. He deeply appreciated nature and wanted people to experience wild places for themselves. And he wrote extensively about his travels so that everyone would want to see what he saw. See the Teacher Prep Note section for helpful resources on John Muir.

2. Introduce the idea of an *inference* as "a guess we can make based on facts."

3. Hand out "John Muir's Favorite Things." Students will read excerpts of pieces John Muir wrote about the places and things he saw. Based on his writing and photos of him, what kinds of inferences can we make about the aspects of nature he loved most?

4 Students will read quotes and look at photos to infer and write five things they believe Muir loved about nature.

Day 3

1. Show students photos of John Muir in nature and tell them they will create a new image of him based on the lists they created the previous day.

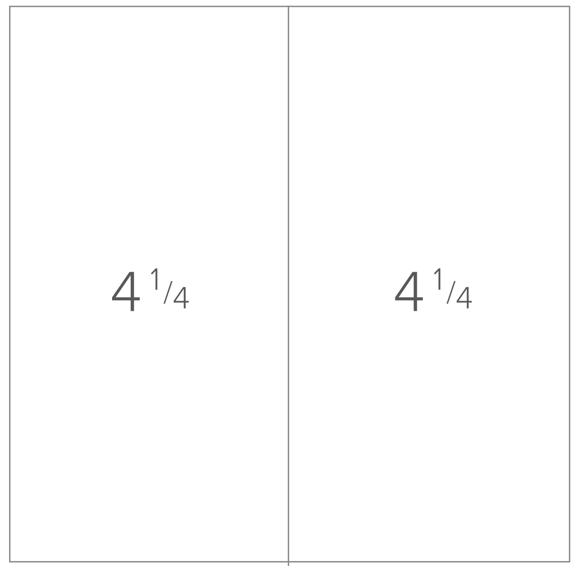
2. Referring to the "John Muir's Favorite Things" handout from Day 2, students will use old magazines, construction paper, and coloring materials to create a landscape containing Muir's favorite things. For example, draw/cut out a mountain range for the background, with trees, rivers, birds, and other animals on top. Encourage students to add things that they infer Muir would appreciate in a National Park.

3. Once students have completed their landscapes, have them add their cutouts of John Muir to the scenes.

Day 4

1. As a class, read the John Muir quote: "Between every two pine trees there is a door leading to a new way of life." Tell students they are going to be making their own special parks between two pines.

2. Have students fold an 11" x 17" sheet of paper, in landscape orientation, according to the diagram. The short ends should meet in the center of the sheet.



3. Each student will create two 11-inch-tall pine trees from construction paper and glue them on the fronts of the doors.

4. Discuss student inferences about Muir's favorite things. Have each student consider his/her favorite elements for a National Park.

5. On the inside panel, have students draw or create out of construction paper a unique National Park landscape that includes their favorite things. This park could combine features of existing parks, or offer a brand new experience. Encourage creativity!

6. Ask students to name their parks.

Day 5

1. As a class, show and read the Yellowstone Act of 1872. Encourage students to focus on the language describing activity in the Park:

> "...set apart as a public park or pleasuring-ground for the benefit and enjoyment of the people; Such regulations shall provide for the preservation, from injury or spoliation, of all timber, mineral deposits, natural curiosities, or wonders within said park, and their retention in their natural condition."

2. Have students create their own Acts to protect the parks they created on Day Four. Use the Student-Created Park Handout on the back of the Yellowstone Act of 1872 Handout.

3. Have students glue/staple/tape their Acts on the right interior panels of their park projects.

> They will need to fold their Acts to allow them to fit.

4. Have students glue/staple/tape their concept map from their Conservation Student Activity Sheet to the left interior panels of their park projects.

5. Have students add their photographs of John Muir to the outside center panels of their park projects.

6. Consider placing these on the wall in the school hallway to mirror the classroom door decorations done by the K–2 students and show solidarity.

CONSERVATION CONTRACT

Student Activity Sheet

I will help conserve ______________________________

for ______________________________ to see.

What's found in nature?

Student Activity Sheet

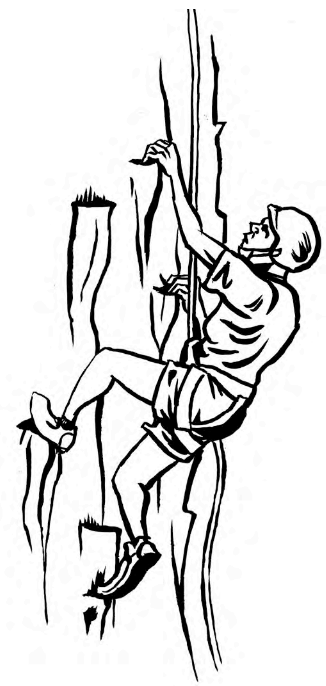
Something I can do at a National Park is:

______________________________'s

National Park Book

John Muir was born in Scotland in 1838, but moved to Wisconsin when he was 11 years old. As an adult, he was inspired by nature and walked across the country from Indiana to Florida. He stopped along the way to draw pictures of the natural things he saw. Later, Muir moved to California and worked to show people the importance of nature. He liked to spend time outside and wrote many books about nature. He said, "…In every walk with nature one receives far more than he seeks."

One hundred years later, we can enjoy our National Parks by:



One night while John and Teddy were camping, five inches of snow fell! Can you imagine camping in the snow? While camping, John and Teddy talked about keeping nature, animals, plants, and water safe for all people to enjoy. They both understood the importance of preserving wild places. As President, Teddy used his power to create five different National Parks.

Theodore Roosevelt, also called Teddy, was born in 1858. He was President of the United States for eight years. In 1903, Teddy visited John Muir at a park called Yosemite. Together, they spent three days camping in the woods. Teddy really enjoyed being in nature and said, “There can be nothing in the world more beautiful than the Yosemite, the groves of the giant sequoias. . .our people should see to it that they are preserved for their children and their children’s children forever, with their majestic beauty all unmarred.”

PARK CONSERVATION

Student Activity Sheet

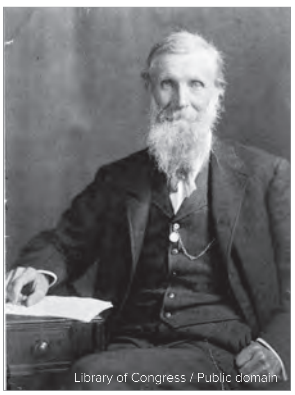
Conservation of

____

(park)

John Muir's Favorite Things

"As long as I live, I'll hear waterfalls and birds and winds sing. I'll interpret the rocks, learn the language of flood, storm, and the avalanche. I'll acquaint myself with the glaciers and wild gardens, and get as near the heart of the world as I can. Near this stream I spent some joyous time in a grand rock dwelling full of mosses, birds, and flowers. As soon as I was able to get out of bed, I crept away to the edge of the wood and sat, day after day, beneath a moss draped live oak, watching birds feeding on the shore when the tide was out. I used to lie on my back for whole days beneath the ample arms or these great trees, listening to the winds and the birds. I began to look forward with delight to the approaching winter with its wondrous storms."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1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

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Name of Park ____

AN ACT TO SET APART A CERTAIN TRACT OF

LAND LYING NEAR ____AS A PUBLIC PARK,
(where is your park located)

Approved ______________________________________
(month, date, year)

Be it enacted by ____________________________________ *of the class of* ________________________________
(student name) (teacher name)

assembled, That the tract of land in the Territories of _____________________________________, lying near
(state where your park is)

_________________________________ and described as follows, to wit, is hereby reserved and withdrawn
(what is your park near)

from settlement, occupancy, or sale under the laws of the United States, and dedicated and set apart as a public park or pleasuring-ground for the benefit and enjoyment of the people; and all persons who shall locate or settle upon or occupy the same, or any part thereof, except as hereinafter provided, shall be considered trespassers and removed therefrom.

SEC 2. That said public park shall be under the exclusive control of the __________________________________
(who will be in charge of the park)

whose duty it shall be, as soon as practicable, to make and publish such rules and regulations as he may deem necessary or proper for the care and management of the same. Such regulations shall provide for the preservation, from injury or spoliation, of all ____
(what will be protected in the park)

within said park, and their retention in their natural condition. ____
(same person who is in charge of the park)

shall also cause all persons trespassing upon the same after the passage of this act to be

____, and generally shall be authorized to take all such
(punishment for people trespassing in your park)

measures as shall be necessary or proper to fully carry out the objects and purposes of this act.

YELLOWSTONE ACT, 1872

AN ACT TO SET APART A CERTAIN TRACT OF LAND LYING NEAR THE HEADWATERS OF THE YELLOWSTONE RIVER AS A PUBLIC PARK,

Approved March 1, 1872 (17 Stat. 32)

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that the tract of land in the Territories of Montana and Wyoming, lying near the headwaters of the Yellowstone River, and described as follows, to wit, commencing at the junction of Gardiner's river with the Yellowstone river, and running east to the meridian passing ten miles to the eastward of the most eastern point of Yellowstone lake; thence south along said meridian to the parallel of latitude passing ten miles south of the most southern point of Yellowstone lake; thence west along said parallel to the meridian passing fifteen miles west of the most western point of Madison lake; thence north along said meridian to the latitude of the junction of Yellowstone and Gardiner's rivers; thence east to the place of beginning, is hereby reserved and withdrawn from settlement, occupancy, or sale under the laws of the United States, and dedicated and set apart as a public park or pleasuring-ground for the benefit and enjoyment of the people; and all persons who shall locate or settle upon or occupy the same, or any part thereof, except as hereinafter provided, shall be considered trespassers and removed therefrom. (U.S.C., title 16, sec. 21.)

SEC 2. That said public park shall be under the exclusive control of the Secretary of the Interior, whose duty it shall be, as soon as practicable, to make and publish such rules and regulations as he may deem necessary or proper for the care and management of the same. Such regulations shall provide for the preservation, from injury or spoliation, of all timber, mineral deposits, natural curiosities, or wonders within said park, and their retention in their natural condition. The Secretary may in his discretion, grant leases for building purposes for terms not exceeding ten years, of small parcels of ground, at such places in said park as shall require the erection of buildings for the accommodation of visitors; all of the proceeds of said leases, and all other revenues that may be derived from any source connected with said park, to be expended under his direction in the management of the same, and the construction of roads and bridle-paths therein. He shall provide against the wanton destruction of the fish and game found within said park, and against their capture or destruction for the purposes of merchandise or profit. He shall also cause all persons trespassing upon the same after the passage of this act to be removed therefrom, and generally shall be authorized to take all such measures as shall be necessary or proper to fully carry out the objects and purposes of this act. (U.S.C., title 16, sec. 22.)

Taking It Further

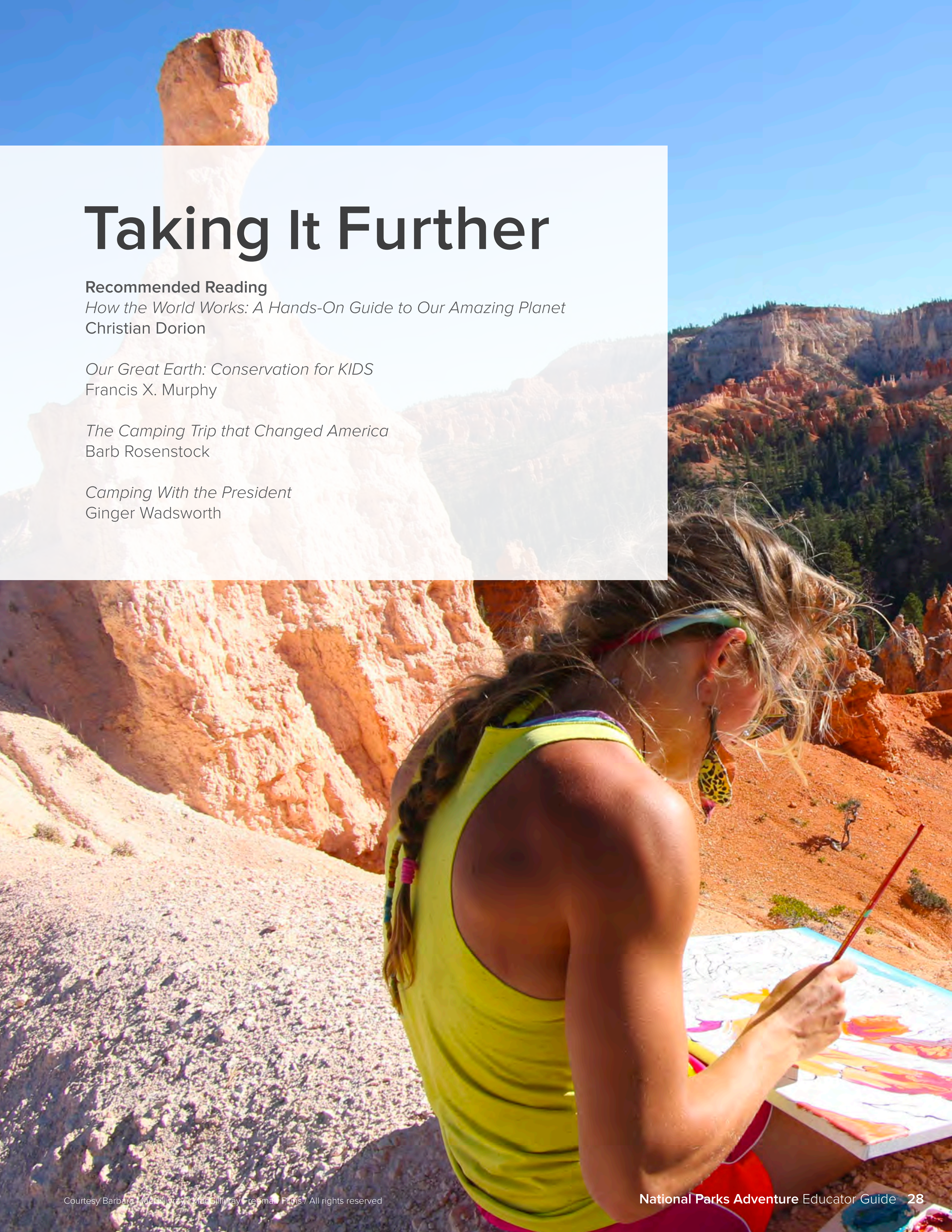
Recommended Reading

How the World Works: A Hands-On Guide to Our Amazing Planet
Christian Dorion

Our Great Earth: Conservation for KIDS
Francis X. Murphy

The Camping Trip that Changed America
Barb Rosenstock

Camping With the President
Ginger Wadsworth



LESSON 2: SUMMERTIME SHADES

Students will design shade structures to keep people cool and protect them from the sun.

Grade Level(s): K–2
Lesson Length: 2 sessions, 45 minutes each

NGSS alignment: K-PS3-2
Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.

K-2-ETS1-2
Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

In the Film

We see Rachel, Max, and Conrad running, biking, and climbing through many national parks. In most of those scenes, the sun is brightly shining and there isn't much shade. Heat-related injury or illness can be a serious problem. Animals have anatomical or behavioral adaptations that help them tolerate or avoid the sun. But humans have a different sort of adaptation: our ability to use tools and innovate to solve problems. So how can humans protect themselves on sunny days? How can a park provide shade for humans without negatively impacting the landscape or the environment?

Key Words/Vocabulary

Structure: Something built from parts put together in a particular way

Shade: An area of darkness produced when something blocks light from the sun or another source

Sunlight: Light that comes from the sun

Materials options for building shade structures

Materials

For the base (options):

☐ For each group, 1 square sheet of cardboard, with clay or Play-Doh as needed to help support the structure; OR

☐ For each group, 1 thick sheet of styrofoam

For the supports (options):

☐ Craft sticks / popsicle sticks; OR

☐ Straws; OR

☐ Chopsticks

For the canopy (options*):

☐ Construction paper or 8.5" x 11" paper

☐ Aluminum foil

☐ Cloth scraps of various weights and colors

☐ Cardboard

☐ Bubble wrap

☐ Clear plastic

☐ Wax paper

☐ Twigs/sticks

*Different materials can lead to discussion about what types of materials will block the sun, and which ones will not. You may want to add other material options to this list depending on what is available to you.

Other supplies:

☐ Scissors

☐ Masking or Scotch tape

☐ 3–4 flashlights or desk lamps

☐ 1 "Summertime Shades Design Process" handout per student

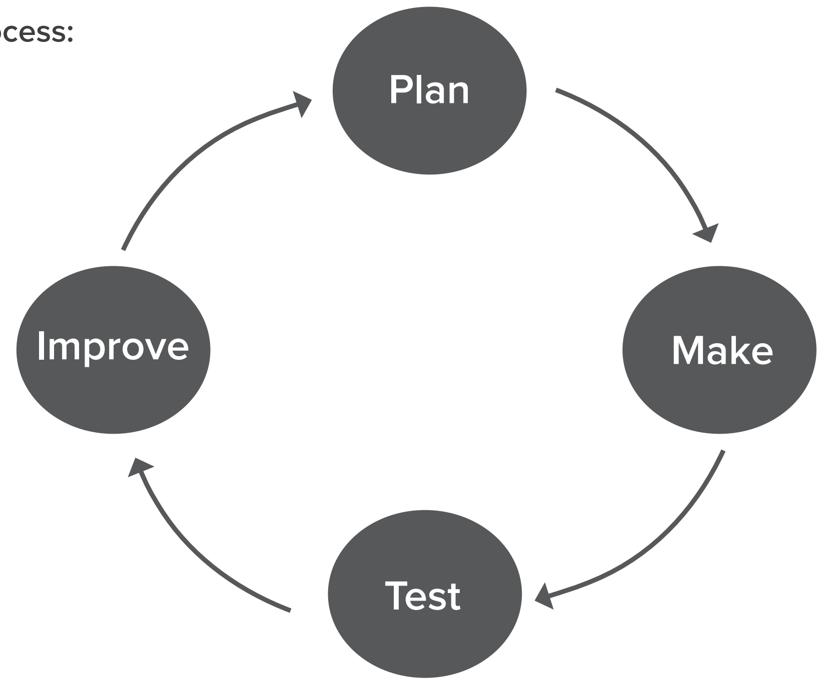
☐ 1 small figurine or copy of the "Printable Person" for each group

Teacher Prep Notes

In an effort to conserve resources, have students bring materials that could be used for building—check the recycling bin! The materials list can be easily adjusted to take advantage of the materials available to you. A sturdy base for each structure is important, and can be made from a thick piece of Styrofoam or support posts set into balls of clay or Play-Doh. Bases made from clay/Play-Doh and posts will also need a sturdy flat surface, such as a sheet of cardboard, to sit on.

This lesson utilizes an engineering design process through which students will design and develop a structure to provide shade for people in a National Park.

The Design Process:



Background

Humans must take deliberate steps to protect themselves from the sun. Heat-related illnesses and injuries can be very serious—even life-threatening if not treated properly.

Sunburns are the most common heat-related injuries. Effects range from pain and blisters to a severe reaction called *sun poisoning* to cancer. Heat-related illnesses can compromise body functions, or even kill. The three most common types—from least serious to most dangerous—are heat cramps, heat exhaustion, and heat stroke. They cause symptoms ranging from an upset stomach and muscle cramps to extreme body temperatures and organ failure.

Doctors, scientists, and engineers are constantly developing and improving methods to protect people from the sun. Doctors not only to treat heat injuries and illnesses, but also educate patients about how to prevent them entirely. Scientists and engineers use their knowledge of physiology and the body to create new products like sunscreen/sunblock, clothes with UV protection, and special foods and drinks to help regulate a body's fluid and electrolyte balance. Engineers design wearable hydration packs and portable shade structures—tents to protect occupants from nearly all environmental conditions, small umbrellas that connect to baby carriers, and hats that provide optimal sun and heat protection.

To Do

Day 1: Plan

1. Introduce the lesson by letting students know they are going to become engineers today! Begin the lesson by asking students the following questions:

   What is an engineer?
   What do we know about the sun?
   What happens when you stand outside in the sun for a long time?
   Why might this be a problem?
   What are some ways people can keep cool when outside?
   What creates shade?

2. Using the engineering design cycle, students will create structures to help protect people from the sun. Explain the importance of planning and brainstorming ideas to find a solution to the problem of sun exposure.

3. At this point, group students and have them brainstorm with their partner/s different structures that could be built. Show them the materials that are available. Leading questions could include:

   What is the structure supposed to do?
   Where will it be located?
   How can we test the materials?
   What will make a material better than others?

4. Hand out Summertime Shades Activity Sheet and have students complete the "Plan" section.

5. Wrap up Lesson 1. Ask students what designs they came up with. Create a large chart with two columns: one with group numbers or names, and one listing materials used. You will add a third column during Day 2 of the lesson, so leave space. Which designs do students think will/will not work? Let students know they will be making and testing their structures in the next lesson/day.

Example design chart:

Group number or names	Materials used	How well did it block the sun? (completely, partially, did not)
group 1	popsicle sticks and fabric	completely blocked

Day 2: Create, Test, Improve

1. Have materials out and ready for students to use.

2. Introduce the design process again. Yesterday the students planned and designed their structures. Today they will make, test, and improve their designs.

3. Review how to work with a partner/s and how important it is that all students help in the process. If necessary, review materials and how to use them.

4. After passing back Summertime Shades Activity Sheet from the previous lesson, have students gather materials and create their structures. Have cutout “Printable People” available for students to put underneath their structures.

5. If using the Design Process handout, have students draw their completed structures.

6. Test the structures with a flashlight, desk lamp, or natural light coming into the classroom. How well does each structure work? Does it keep the sun out from underneath the structure?

7. As groups test their structures, update the chart started yesterday. How well did each structure work?

8. Have students reflect on their design process handout. What parts of their structures could they improve? Have students do a second iteration or create a new structure with different materials for a different surface (i.e. rocky, sandy, etc.)

   What materials worked best?
   What materials did not work well? Why?
   Was anyone able to improve the design?

9. Once all students have a chance to make, test, and reflect on their structures, bring the group together. Review/finish the materials chart.

10. Do a class walkthrough so all students can see each others’ designs.

SUMMERTIME SHADES

Design Process Activity Sheet

NAME: ______________________________

I can design and create a structure that will provide shade from the sun.

PLAN

Materials

A sketch of my sculpture

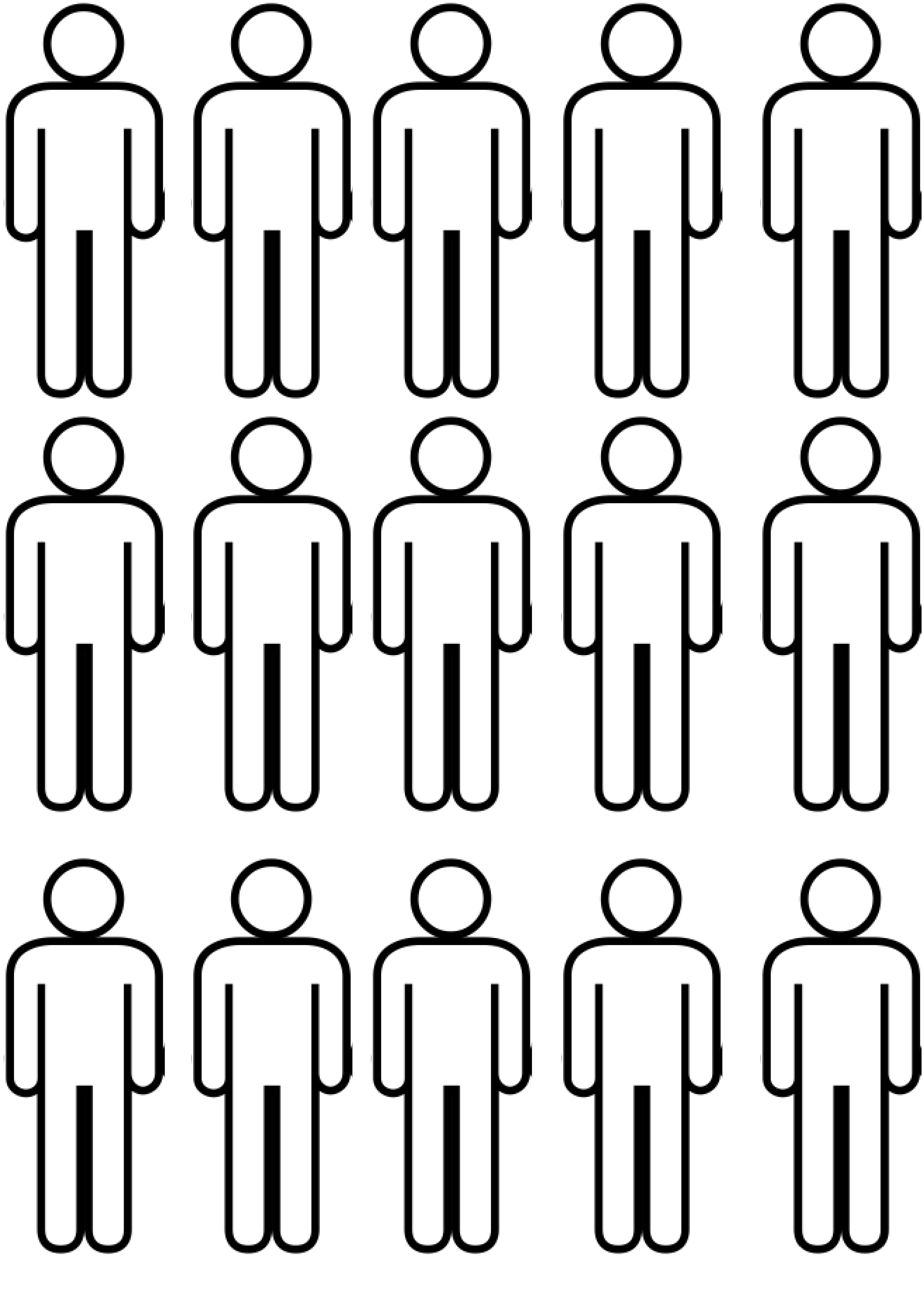
MAKE

My structure looks like

Did it keep the sun out?

IMPROVE

I can make my structure different by



Taking It Further

NGSS alignment: K-PS3-1
Test each material under a desk lamp with a thermometer underneath the structure.

NGSS alignment: K-ESS2-2
Create a structure for a side of a cliff or over water.

NGSS alignment: K-PS3-2
Create a structure for animals to stay out of the sun in the summer.

Recommended Reading
Sunshine Makes the Seasons
(Let's-Read-and-Find-Out Science 2)
Franklyn Branley

Jump Into Science: Sun
Steve Tomecek

Beneath the Sun
Melissa Stewart

LESSON 3: ANIMAL ADAPTATIONS

Students will explore animal adaptations using appropriate picture books. Students will create new animals and draw them in their habitats.

Grade Level(s): K–2
Lesson Length: 45-60 minutes

NGSS alignment: 1-LS1-1
Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.

In the Film

In the film we see just a few of the many animals protected in the National Parks. All of them have adapted to the environments in which they live. Prairie dogs have many adaptations that allow them to thrive on the flat grasslands around Devils Tower National Monument. Wet, marshy Everglades National Park is home to alligators and many different species of shorebirds. And in Alaska, cold-adapted brown bears are able to fish in the rivers of Katmai National Park.

Key Words/Vocabulary

Structural Adaptation: A physical feature of an organism—like fur, eyelashes, or scales—that helps it survive in its environment.

Materials

☐ Crayons or colored pencils

☐ Paper

☐ Animal Cards, 1 set per 4 students
(printed on colored paper according to the chart in the Teacher Prep Notes)

☐ Picture book(s) about animal adaptation
(see suggestions in the Taking it Further section)

Teacher Prep Notes

Copy each category of Animal Cards on a different color paper to help better direct the activity. For example, use blue paper for the animals in the “mouth” column, or green for the animals in the “eyes” column. Each group of four students should receive a full set of 24 cards. Students will draw one card of each color to create a complete animal. Walk through each step with the students, or allow them to work independently if they are able to read the key.

> ***Nature is a good mother, and sees well to the clothing of her many bairns—birds with smoothly imbricated feathers, beetles with shining jackets, and bears with shaggy furs. In the tropical south, where the sun warms like a fire, they are allowed to go thinly clad; but in the snowy northland she takes care to clothe warmly.***
>
> **—John Muir**

Background

Every organism on the planet is adapted to its environment. Camouflage or claws, fur or scales, adaptations help organisms survive. (This is true of humans, too.) In the film, we see three apex predators from the tops of their food chains: bears, alligators, and humans. We also see shorebirds and prairie dogs, which occupy the middles of their food chains. No matter what they eat or are eaten by, all these animals have evolved adaptations that help them survive in their environments.

Predators from domestic dogs to birds of prey eat prairie dogs. But their highly developed sense of vision helps them avoid these larger predators—at least some of the time! The shorebirds of Everglades National Park are also food for larger predators, but their adaptation of flight can sometimes help them escape. These birds have sharp, spear-like beaks—adaptations that help them catch fish and amphibians. The long necks of the shorebirds are also an adaptation; they extend the reach of their beaks. American alligators are also found in the Everglades. These apex predators are part of a family that has remained virtually unchanged for over 80 million years. Alligators and their close relatives have survived multiple extinction events, including the one that wiped out the dinosaurs. They have no natural predators, and in a stable environment, the species has not been forced to adapt for millions of years. In Katmai National Park, brown bears thrive on a diet heavy in nutrient-rich salmon. They’ve learned to catch the fish in their mouths while the salmon swim upstream and try to breech small waterfalls. The brown bears of Katmai don’t rely entirely on their sharp teeth and claws to catch salmon, however. Bears jaws have evolved to take advantage of a diverse diet which also includes nuts, berries, honey combs, and grasses. And brown bears’ front paws allow them to dig up plant roots—another food source.

One of humankinds' most important adaptations is our ability to use tools. Without wings, Conrad, Rachel, and Max use tools—ropes, anchors, carabiners, etc.—to climb Devils Tower. Without claws, they used crampons, screws, and ice axes to climb the frozen waterfall in Michigan. While climbing the ice, they also had to adapt to the freezing temperatures in that environment. They wore gloves, boots, heavy jackets, insulated pants, winter hats, and other layers to keep their bodies warm. The ability to create and use tools is an adaptation that has allowed humans to survive and thrive in any environment.

Whether a tiny prairie dog or a huge brown bear, each species must adapt or risk extinction. Keen vision, sharp teeth, tough claws, warm fur, and hardened scales are all potentially useful adaptations—but only in specific environments. A prairie dog born with scales and the powerful jaw of an alligator wouldn't survive on the grasslands surrounding Devils Tower. Likewise, a brown bear wouldn't find a sharp beak an advantage while foraging for berries in Katmai National Park. Beneficial adaptations must be specific to the environment that the species lives in. It's a matter of life and death.

To Do

1. Choose one or more of the books listed in the Taking it Further section (or your own favorite book about animal adaptations), and read it to the class.

2. Discussion: Talk about different animals and the structural adaptations they have. How do the animals use those structures to eat? To move? To defend themselves? To stay warm or cool?

3. Describe the task that students will be completing. In their groups students will sketch an imaginary animal with different adaptation bases on the card they draw from their group pile. They will draw one card of each color. The chosen card determines the animal body part that the color represents.

> **For example,** if they choose a bird from the body category, they should sketch a bird body on their paper.

4. Place students into groups of four and give each group a set of cards.

5. Have each student choose a **body** card. Students then draw their animal body on their paper.

6. After drawing the body, students choose a **feet** card and draw their animal's feet.

7. Next have students choose a **tail** card and draw a tail on their animal.

8. After the tail is drawn, students should then choose a **mouth** card, followed by **eyes**, then **ears**, drawing each part as it is chosen.

9. When students have drawn one of each color/type of card, their animal should be complete.

10. Using the information on the cards and what they already know about the different animal parts, students need to add the animal's habitat to their overall drawing.

11. Conclusion: Discuss the following questions: Where does your animal live? What does your animal eat? How does your animal protect itself?

Mouth

Robin:
eats insects, worms, cracks seeds

Grey wolf:
sharp, pointed teeth for eating meat

Bison:
flat teeth grind up grasses and other plants

Anteater:
long tongue reaches inside small spaces to grab food

Mouth

Robin:
eats insects, worms, cracks seeds

Grey wolf:
sharp, pointed teeth for eating meat

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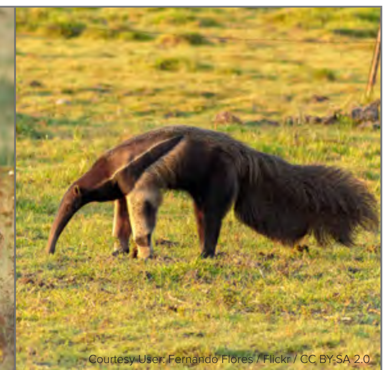
flat teeth grind up grasses and other plants



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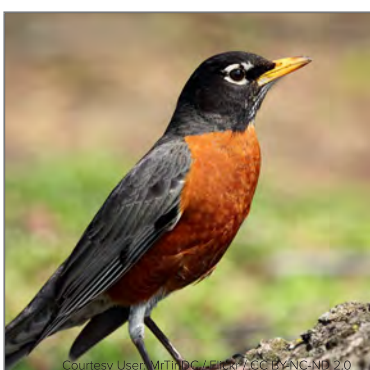
long tongue reaches inside small spaces to grab food

Mouth



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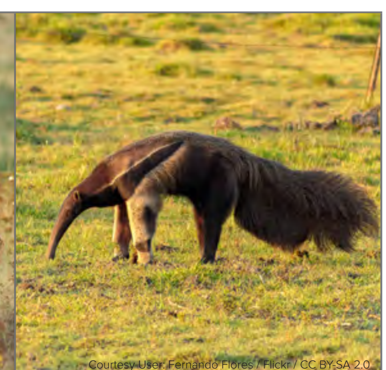

Anteater:
long tongue reaches inside small spaces to grab food

Tail


Courtesy Eric Engbretson, USFWS

Rainbow trout:
tail moves the fish
through the water


Courtesy Cody Pope / Wikimedia Commons / CC BY-SA 2.5

Opossum:
grasping tail helps
it climb trees


Courtesy User: Paul Ritchie / Flickr / CC BY-NC-ND 2.0

Gecko:
tail breaks off if
a predator grabs it
(It will grow back!)


Courtesy User: Mark Dumont / Flickr / CC BY-NC 2.0

Arctic fox:
wraps its bushy
tail around itself
to stay warm

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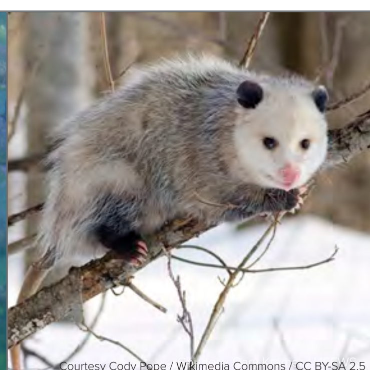
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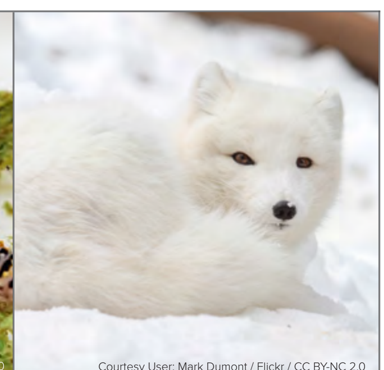
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Arctic fox:
wraps its bushy
tail around itself
to stay warm

Body

Western rattlesnake: scales hold in moisture so the snake can live in the desert

Loon: secretes an oil to coat its feathers, making it waterproof

Musk ox: thick coat of hollow hairs insulates it from the cold

Polar bear: stays warm with a thick layer of fat/blubber

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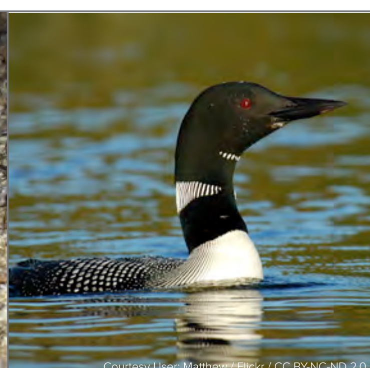

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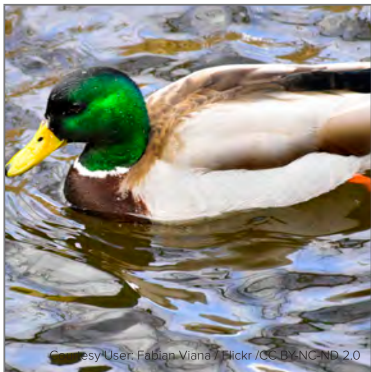
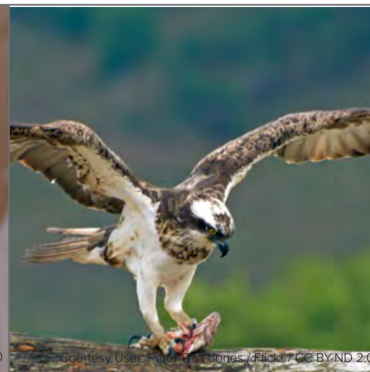


Mallard:
webbed feet make paddling through water easy

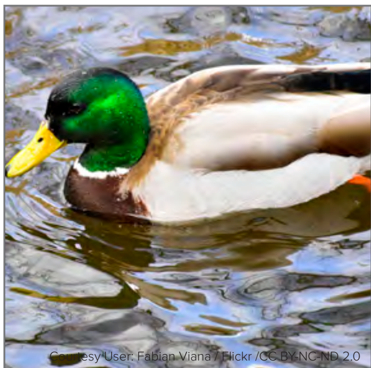
Grey tree frog:
sticky feet to help it climb trees



Osprey:
talons grasp the live fish it eats

Lynx:
wide, furry paws act like snowshoes to help the animal walk across snow

Feet



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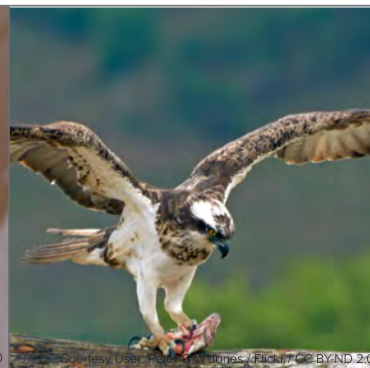

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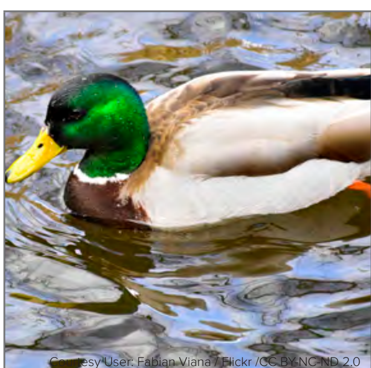

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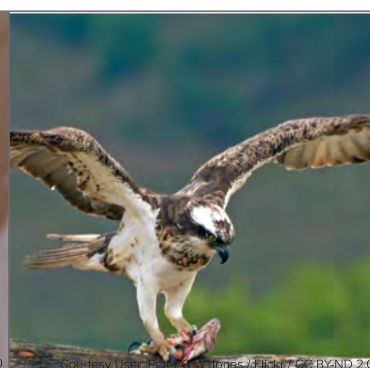

Osprey:
talons grasp the live fish it eats

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wide, furry paws act like snowshoes to help the animal walk across snow

Eyes

Bald Eagle:
can see fish underwater from hundreds of feet up in the air

Racoon:
large eyes and pupils, as well as reflectors in the back of the eye, help them see in the dark

Mountain goat:
can see almost 360 degrees and up to a mile away

Bearded seal:
whiskers help it “see” food on the ocean floor

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can see fish underwater from hundreds of feet up in the air

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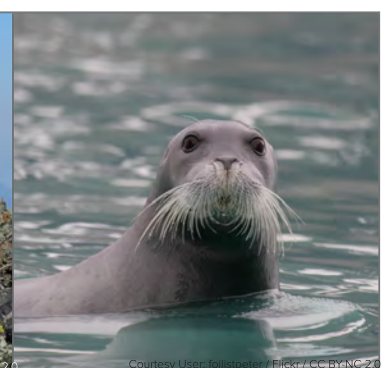

Bearded seal:
whiskers help it “see” food on the ocean floor

Feet


Courtesy User: Jack Wolf / Flickr / CC BY-ND 2.0

Jackrabbit:
large ears help
it stay cool


Courtesy User: Devra / Flickr / CC BY 2.0

Pallid Bat:
uses echolocation
to “see” with its ears


Courtesy User: Steve / Flickr / CC BY-SA 2.0

Beaver:
closes its nostrils and ears
to keep water out


Courtesy User: Brandon Warren / Flickr / CC BY-NC 2.0

Owl:
changes its feather
pattern to improve
its hearing

Feet


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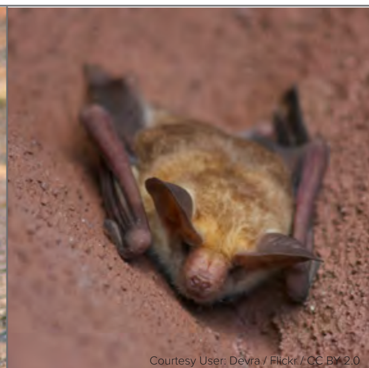
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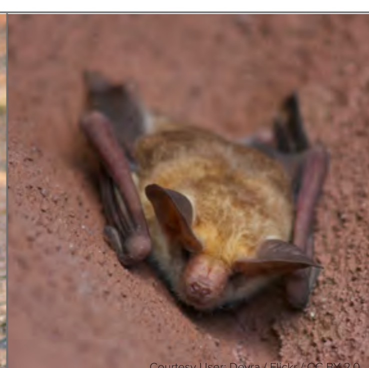
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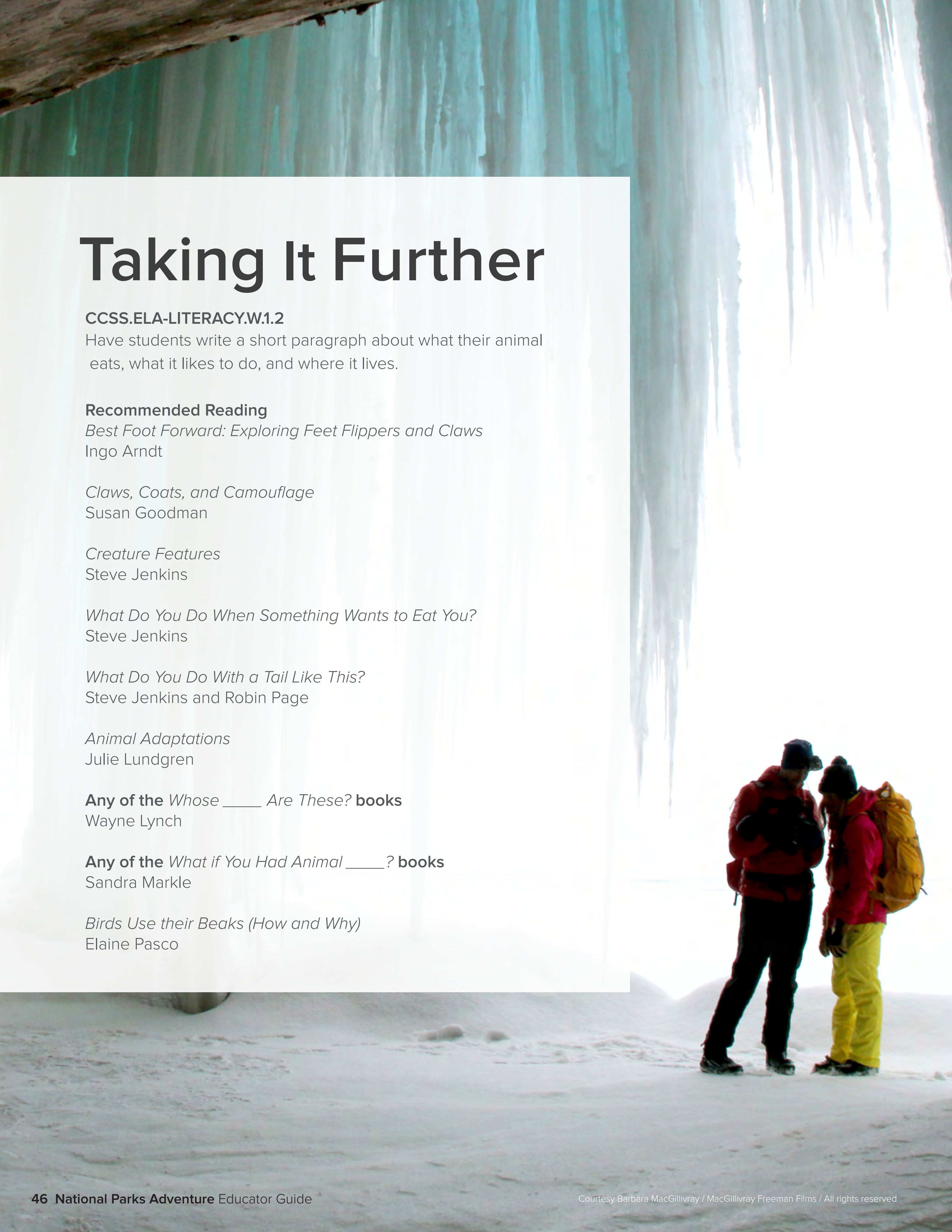


Taking It Further

CCSS.ELA-LITERACY.W.1.2
Have students write a short paragraph about what their animal eats, what it likes to do, and where it lives.

Recommended Reading
Best Foot Forward: Exploring Feet Flippers and Claws
Ingo Arndt

Claws, Coats, and Camouflage
Susan Goodman

Creature Features
Steve Jenkins

What Do You Do When Something Wants to Eat You?
Steve Jenkins

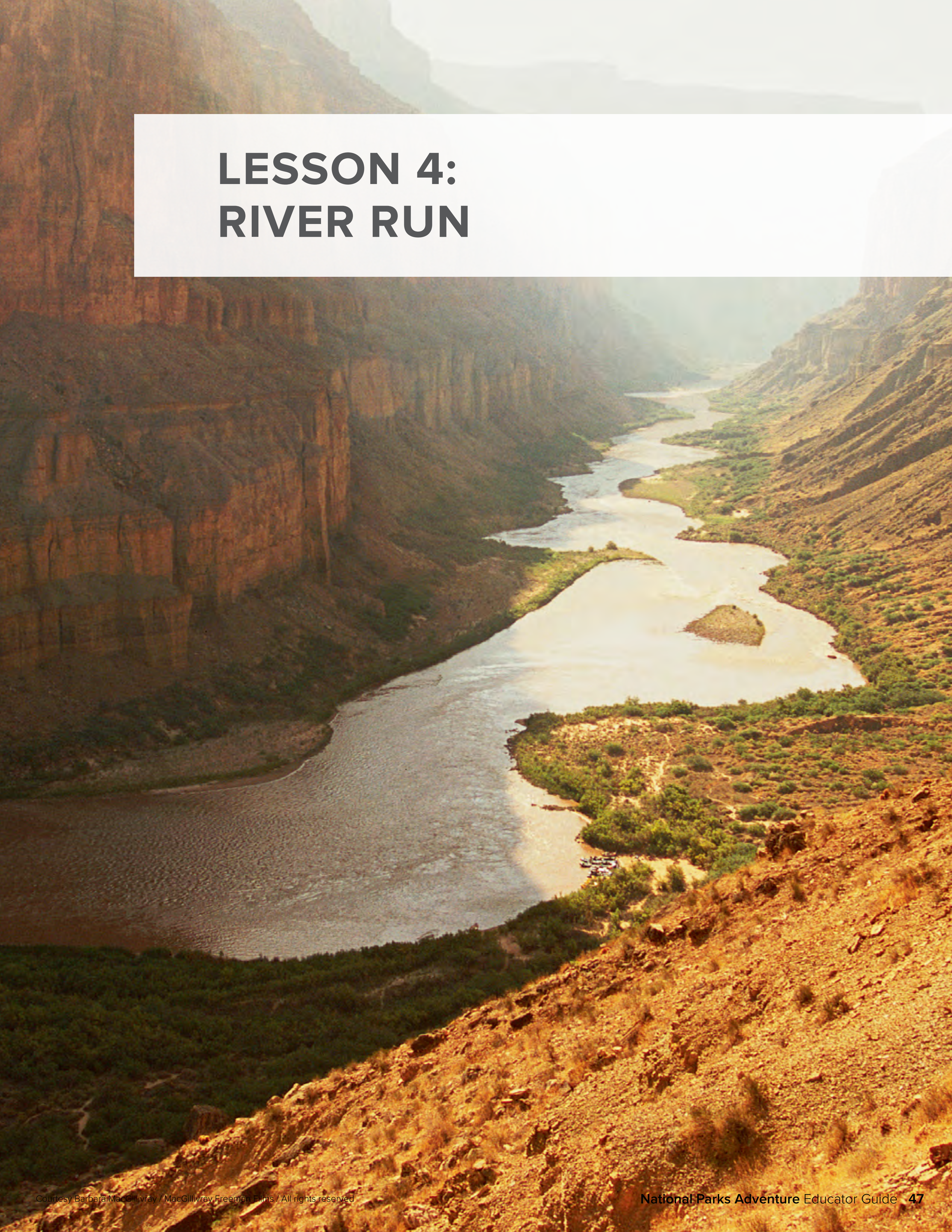
What Do You Do With a Tail Like This?
Steve Jenkins and Robin Page

Animal Adaptations
Julie Lundgren

Any of the *Whose _____ Are These?* **books**
Wayne Lynch

Any of the *What if You Had Animal _____?* **books**
Sandra Markle

Birds Use their Beaks (How and Why)
Elaine Pasco



LESSON 4: RIVER RUN

Students will create models of watersheds and observe the effects of pollution on them.

Grade Level(s): K–2

Lesson Length: 60 minutes

NGSS alignment: 2-ESS2-1

Compare multiple solutions designed to slow or prevent water/wind erosion.

In the Film

From clear and calm Yellowstone Lake in Wyoming to the rushing rapids of the Colorado River in the Grand Canyon, *National Parks* highlights some of America's wondrous rivers and bodies of water. Rivers and lakes are home to animals, and offer opportunities for recreation and renewal for people. But where does the water come from? What happens if the water gets polluted?

Key Words/Vocabulary

Watershed: An area of land that contributes water to a river or lake

Downhill: Toward the bottom of a slope. Water always moves downhill.

River: A channel of water flowing toward another body of water, such as a lake or ocean

Pollution: The introduction of harmful things into the water, air, soil, etc.

Environment: All the things that make a place what it is; the air, land, water and things that are present in a particular place

Materials

One set per group of three students unless otherwise noted

☐ ¼ sheet newspaper

☐ 14” x 18” piece of plastic cut from a plastic shopping bag, garbage bag, or plastic sheeting

☐ Pipette or half of a drinking straw

☐ Coffee filter (1 per student)

☐ Plastic cup (to hold water)

☐ Permanent markers (blue and black)

☐ Water-soluble markers (4 assorted colors)

☐ Plastic tray, bus tub, cookie sheet, or other container to catch water

☐ Water pitcher (1 per class)

☐ Blue food coloring (a few drops per class)

☐ Watershed illustration

Materials for River Run

Teacher Prep Notes

This activity can be messy, so protect student workspaces with newspaper. Fill a pitcher with water and add a few drops of food coloring to tint it pale blue. Fill cups (1 per group of 3 students) about 1/3 full of the blue water. Included in this guide is a generic watershed illustration. To make the activity more relevant, use a local watershed map instead. The U.S. Geological Survey (USGS) and the Environmental Protection Agency have websites that allow you to look up your watershed: http://water.usgs.gov/wsc/map_index.html or http://cfpub.epa.gov/surf/locate/index.cfm

> ***The sun shines not on us but in us. The rivers flow not past, but through us.***
>
> **—John Muir**

Background

When rain falls on the Earth, that water flows over or under the ground to a stream, river, or lake. Eventually, the water flows all the way to the ocean. The land that the water flows across is called a watershed or drainage basin. Watersheds come in different sizes. Rain falling on the sidewalk flows downhill to create puddles. And water flows downhill to the Mississippi River via streams and creeks all along its length—over 2,000 miles! Every spot on Earth is a part of a watershed. Your school, home, and playground are part of a watershed.

It's very important to keep watersheds clean, because polluted water in one area can affect the environment hundreds of miles away. For example: Every summer, at the height of the growing season, a dead zone forms in the Gulf of Mexico near the Mississippi River delta. (A dead zone is a large area of water that contains very little oxygen, and so can't support life.) This happens because fertilizers on farm fields in the Midwest wash into streams and rivers that feed into the Mississippi. These fertilizers contain the nutrients phosphorus and nitrogen, which encourage plants to grow. The Mississippi River carries the nutrients into the Gulf of Mexico, where they cause huge blooms of algae. When the algae die, they decompose and use up the oxygen in the water. Organisms leave the area or die, disrupting the food chain. Dead zones like this one occur along many of the world's coastlines. In Maryland's Chesapeake Bay, an estimated 75,000 tons of potential seafood is killed each year in a dead zone likely fueled by animal waste from farms in Pennsylvania.

To Do

Introduction

1. Begin lesson by discussing what an environment is. If you were to take a plane trip all over the United States, would the view out the window always be the same? What kinds of places would we see? (towns, farms, forests, rivers, etc.) Explain that these are different types of environments. Discuss water environments—lakes and rivers. Ask who has been to a lake or river. How are they different?

2. Have students imagine what a lake would look like if they were flying over it in a plane. Then have them imagine what a river would look like. Show the picture of the watershed and point out the river and the lake.

3. Focus on rivers and how they move, what they carry, how they're used, etc. Rivers flow downhill, and each has a beginning and an end. Many insects, birds, fish and mammals live in river environments. People use the flowing water of rivers to generate electricity and move cargo. We get drinking water from rivers. And we also use rivers for recreation—fishing, boating, and swimming. Sometimes, things get into the water that shouldn't be there—plastic bottles, rusty metal, and even harmful chemicals.

4. Introduce the word watershed. Using that same watershed illustration describe a watershed. A watershed is the land uphill from a river or a lake. Water from rain or snow falls onto the highest point, then flows down into rivers and lakes. Tell students that they will now be creating model watersheds.

Watershed Activity

1. Show students how to set up the experiment by crumpling a sheet of newspaper, placing it on the tray, and putting a sheet of plastic over it.

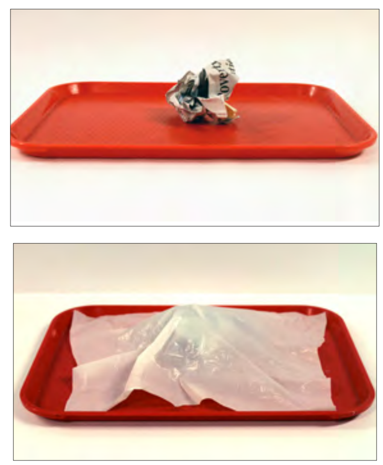
2. Demonstrate how to use the pipette or straw to drip water onto the highest part of the plastic. Before releasing the water, ask students to predict where it will flow. Drip a few drops of water (compare it to rain or snow) onto the highest part of the watershed model. Watch where the water flows. Ask students if the water followed the path they predicted it would.

3. Tell students that they will work in groups of 3, and that each student will apply 3 squirts of water for a total of 9 squirts.

4. Students create their watershed model and do the experiment.

5. Discuss the following questions:

In which direction did the water travel? (downhill)
Describe the shapes of water's paths—were they straight, crooked?
Where did the water end up? (a "lake")
Did you have more than one "river"?
Where was the land relative to the river/lake? (uphill)
Was the water in the river clean or dirty?
Why was it clean?



Step 1: Set up the experiment

Step 2: Dropping the water onto the highest part of the model

Watershed Pollution

1. Refer back to the initial discussion about how, sometimes, things get into rivers and lakes that don't belong there. In the model we just looked at, there was no pollution.

Let's look at what happens if we add some.

2. Demonstrate how to make the "town." Using a black permanent marker, draw roads and houses on a coffee filter as if seen from an airplane. Use a blue permanent marker to draw in a river and/or lake.

3. Use water-soluble markers to draw sources of pollution or excess nutrients (tell as a story): trash, oil leaking from a car, spilled paint, dog poop, etc.

4. Drape the coffee filter over the crumpled newspaper from the watershed experiment. Pretend to drip water from a pipette onto the coffee filter. Ask students to predict what will happen to the trash, etc.

5. Individually, have students draw their towns, rivers, and pollution sources.

6. Each student should take turns draping their coffee filter over their piece of crumpled newspaper. Then each student uses the pipette or straw to apply 5 squirts of water to the highest spot on the model, just as in the first experiment.

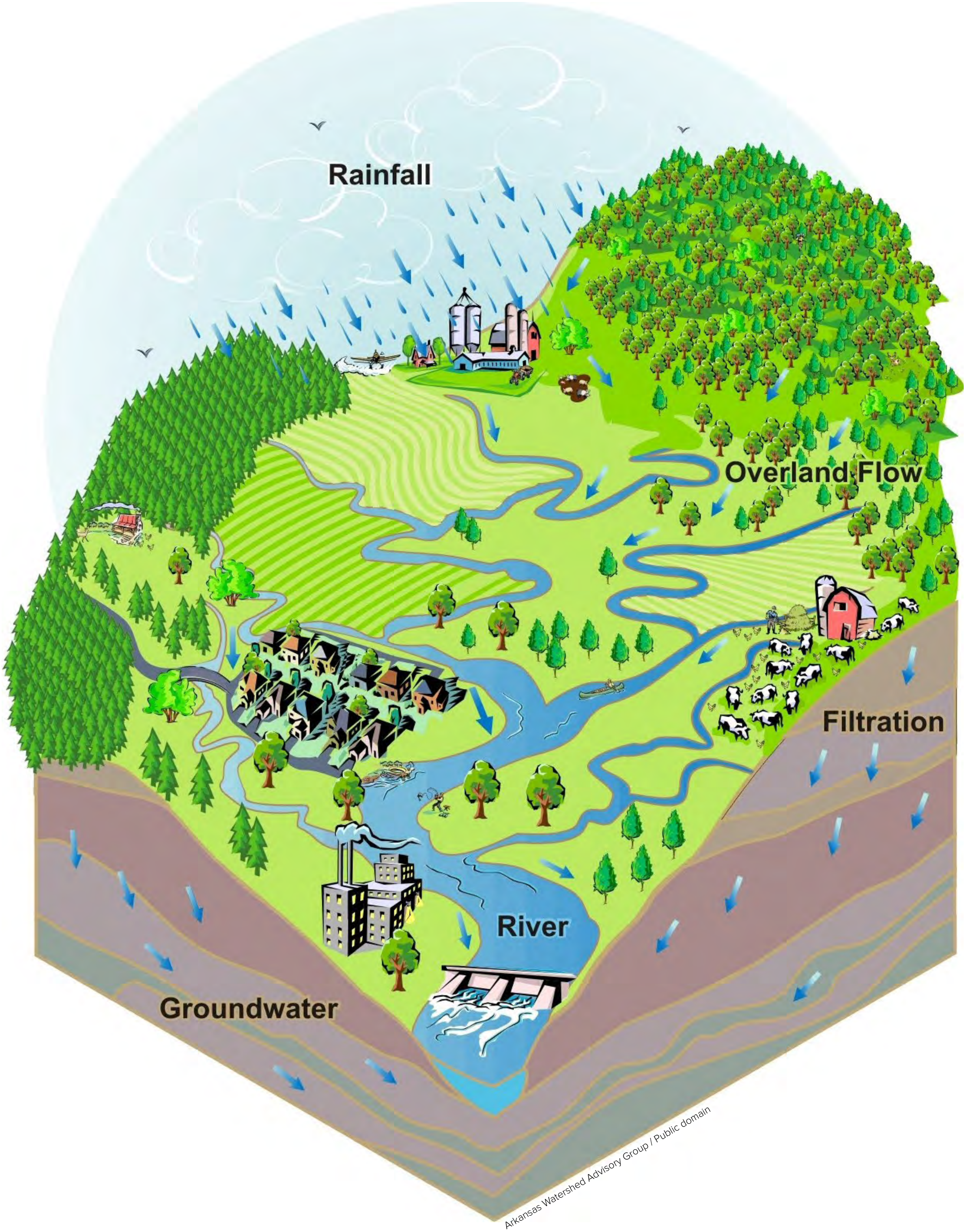
7. Encourage students to observe what happens to the coffee filters. (They should see the water-soluble marker "pollution" running down the coffee filter.)

8. Have students look at the newspaper under their coffee filters. What do they see? (They should see water-soluble marker, representing groundwater pollution, on the newspaper.)

9. Show the watershed illustration again and discuss the following.

Offer a scenario: if rain fell on a pollution source, where would the pollution eventually end up? (in the river or lake)

What would that do to the water?
How would that affect the animals living in the water?
How would the pollution affect humans?
What can you do to the land around your school or house to protect rivers and lakes?



Arkansas Watershed Advisory Group / Public domain

Taking It Further

NGSS Alignment: K-ESS3-3
Have students make a pledge to keep the water from getting polluted

www.smm.org/deadzone
Explore the Science Museum of Minnesota's Dead Zone web interactive

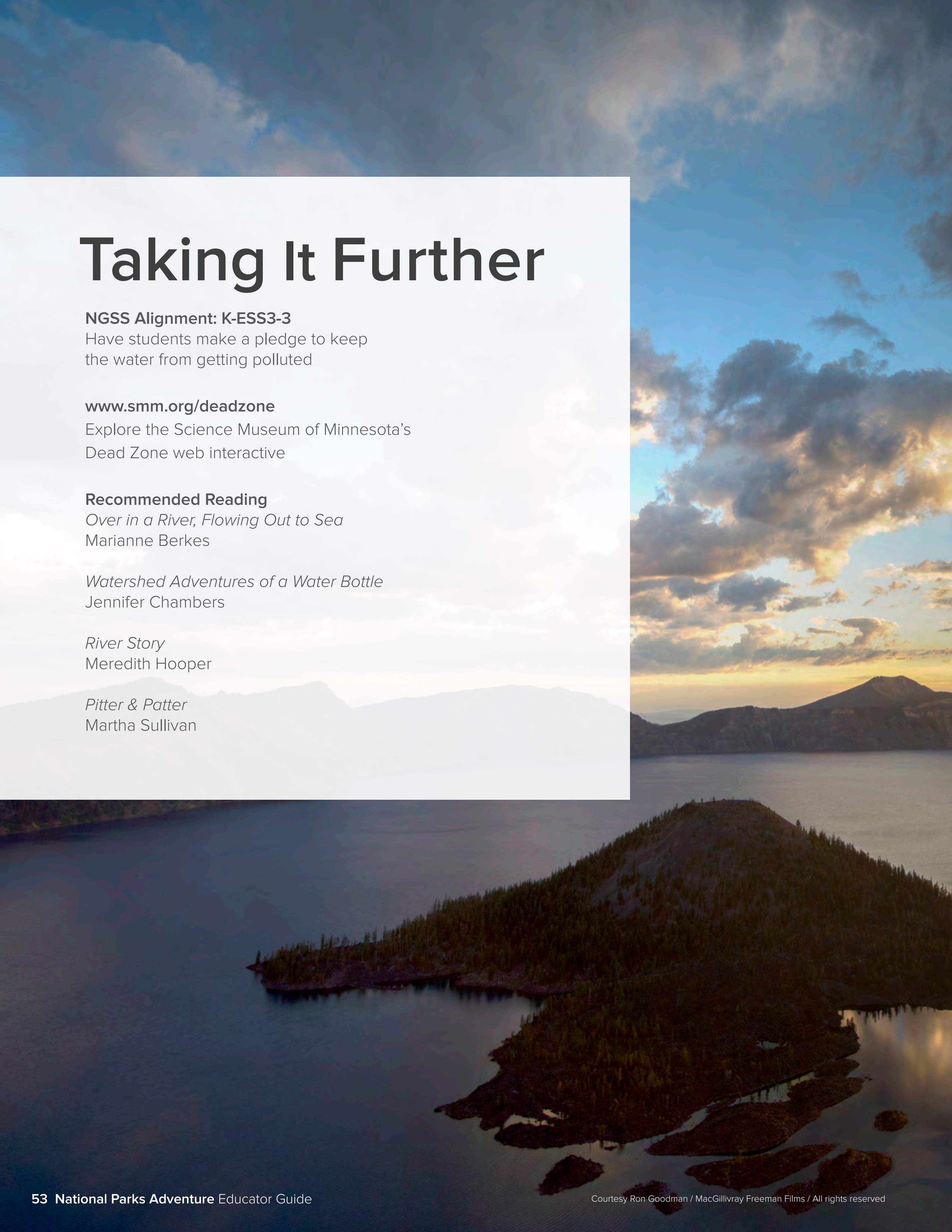
Recommended Reading

Over in a River, Flowing Out to Sea
Marianne Berkes

Watershed Adventures of a Water Bottle
Jennifer Chambers

River Story
Meredith Hooper

Pitter & Patter
Martha Sullivan



LESSON 5: SURVIVING SOLO

Students will use simple household materials to make compasses and use them to direct their classmates to find an object in the classroom.

Grade Level(s): 3–5
Lesson Length: 60 minutes

NGSS alignment: 3-PS2-4
Define a simple design problem that can be solved by applying scientific ideas about magnets.

In the Film

In the film, Rachel, Max, and Conrad travel to eleven national parks. We see them running in Bryce Canyon National Park and walking through Redwood National Forest. Hikers, runners, and explorers should stay on the trails when spending time in any park. But what happens if your trail is washed out in a flash flood and you're not sure which direction to go to reach safety? What if your GPS or cell phone aren't working, or if your compass gets lost or broken?

Key Words/Vocabulary

Compass: An instrument with a magnetic needle used to measure geographic direction

Compass Rose: A circle showing the principal directions

Materials

One set per each group

☐ Large plastic lid like that from a peanut butter jar

Note: Your lid/container needs to be large enough for the milk cap to float around freely and for the needle/pin or paperclip to turn freely.

☐ Needle, straight pin, or small straightened paperclip

☐ Magnet

☐ Cap from a plastic milk jug (or a coin-sized slice of cork)

☐ Water

☐ "Survival Pack" handout for each student

☐ Paper

Materials to make one compass. Note: the magnet does not need to be a ring magnet—any magnet will work.

Teacher Prep Notes

Some students may be very unfamiliar with spending time in the wilderness, and scaffolding may be required in order for them to be successful with the activities. A needle is used as part of the construction of the compass. Discuss proper handling of the needle with students so no injuries occur.

> ***The farther one gets into the wilderness, the greater is the attraction of its lonely freedom.***
>
> **—Theodore Roosevelt**

Background

The earliest humans used landmarks to navigate, but they quickly learned to use the sun. Knowing that the sun sets in the western sky, they could determine direction during the day. (To go north in the afternoon, keep the sun on your left.) But navigation at night was still a complicated matter. Later, people realized that the stars in the sky are constant, not randomly placed each night. With a working knowledge of astronomy and how the positions of constellations and other planetary bodies change over seasons, humans were able to explore and navigate over greater distances—and, more importantly, find their way back home.

The first magnetic compass was developed in Asia around 1,000 years ago. (It made its way to Europe some 300 years later.) With magnetic compasses, people could determine direction, day or night. An intrepid person with a compass, a map, and a system for measuring distance could navigate fairly accurately. Exploring, and even ocean travel, became more common. As the human groups that pioneered navigation discovered unexplored areas of the world, they made new and more exact maps. Their travels expanded, sometimes only for the sake of exploration and mapmaking. In London in 1757, John Bird created the sextant, an instrument which made at-sea navigation by the stars safer and more precise. Famed American explorers Merriwether Lewis and William Clark used a sextant on land during their Corps of Discovery Expedition.

The invention of such specialized equipment allowed navigation on land and at sea. But humans have always yearned to explore farther—beyond the surface of the Earth. To do so, we had to learn to navigate in three dimensions instead of two. Most aeronautical navigation is done by computers that show pilots their course. Further navigation is done by flight controllers on the ground using radar and similar computers to the ones pilots use. In space, astronauts depend on flight computers as well as a mission control station on the ground which tracks them and ensures they are on-course. But like the oceanic explorers of the past, modern astronauts are also taught to make star readings and use the sky to plan their course.

Today, we have many tools for easy, precise navigation, including detailed maps, satellite imagery, and phones and other devices that take advantage of the Global Positioning System (GPS). But when these fail or are unavailable, we can fall back on some of the essentials of survival and navigation: good planning and a simple compass.

To Do

Day 1: Thinking about survival

1. Hand out copies of the “Survival Pack” handout or project it on a screen.

2. Have groups identify each item and its use in an outdoor survival situation.

3. Questions: What items in the pack are necessary for survival? What items could be left out of the pack? Are there any items you would want to add to the pack? *Remember to think about what is necessary for survival.

4. Discuss: One of the things in the survival pack is a compass. What is a compass used for? How could you find your way if you didn’t have a compass?

Possible responses: Use the sun or stars to figure out direction. Look at a map.

Part 2: Making a compass

1. Discuss the history of navigation. Use the Background section of this plan to help you facilitate this discussion.

2. Pour water into the large lid (or shallow container) until the lid or container is half full.

3. Lay the plastic milk cap gently in the water so that the top of the cap touches the water.

4. Rub the magnet along the needle about 30 times. Make sure to only rub in one direction!

5. Lay the needle carefully on top of the floating milk cap

6. Allow the needle to spin without disturbing it. Watch to see which way the needle points. It may turn one way and then the other before settling on north.

7. How do you know which end of the needle points north? (Rubbing the magnet on the needle caused it to become magnetized—the needle is now a weak, temporary magnet. The magnetized needle interacts with Earth's magnetic field, aligning with the field to point north.)

8. Have students turn the needle/milk cap in the water and see if the needle rotates back to north.

Part 3: Using the compass

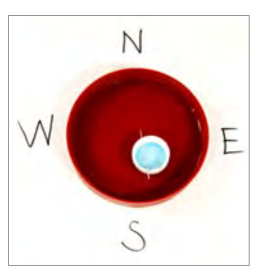
1. Have students put a piece of paper down on the table or desk underneath the compass. Use the compass to identify north. Have students create a compass rose on their paper and lay the compass on top. The compass will stay on top of this paper and table for the remainder of the activity.

2. Have students designate one person in each group to be the “finder.”

3. The other student(s) in each group are the “directors.” They choose an object in the classroom that they want the finder to locate. Don’t tell the finder what the object is!

4. Ask the directors to give the finders directions to the mystery objects in the classroom. Example: “Walk 3 steps north, then 2 steps west.”

5. The directors continue to give directions to the finders until the the mystery objects are found.



6. Once the objects are found, have the students trade roles.

SURVIVING SOLO

Student Activity Sheet

Add these items to your backpack:

Taking It Further

NGSS alignment: 3-5-ETS1-2
For an engineering lesson, have students use different materials such as a different liquid, a different container, or different sized needles.

NGSS alignment: 5-ESS1-2
Research and test other methods (shadow method, watch method, stars) of determining direction.

Have students create a map of the classroom—be sure to have them include a compass rose on their map.

Recommended Reading

Julie of the Wolves
Jean Craighead George

My Side of the Mountain
Jean Craighead George

Hatchet
Gary Paulsen

The Sign of the Beaver
Elizabeth George Speare

The Swiss Family Robinson
Johann David Wyss

LESSON 6: LAYERS OVER TIME

Students will make models of a section of the earth and practice identifying the age of the rock layers relative to each other.

Grade Level(s): 3–5

Lesson Length: 60 minutes

NGSS alignment: 4-ESS1-1

Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

In the Film

In Bryce Canyon National Park, Rachel, Max, and Conrad run past tall rock formations called “hoodoos.” These stone spires formed gradually as winter snows and frost carved away the surrounding rock. The processes of erosion have revealed ancient layers of stone in the hoodoos. Some of these layers date back to the time of the dinosaurs.

Key Words/Vocabulary

Relative dating: Determining the age of a rock or geologic event in comparison to another rock or event

Absolute dating: Giving an exact age for a rock or geologic event

Stratigraphy: The study of rock layers

Stratum: A rock layer (pluralized as “strata”)

Law of superposition: A scientific principle stating that in an undisturbed sequence of rock layers, the lower layers of strata are older than the layers above

Materials

☐ Golf ball-sized piece of soft Play-Doh or clay for each student

☐ Small, dry, consumable materials such as pasta, beans, rice, pony beads, or pop tabs (at least 4 different options)

☐ Dry ground cover materials, such as Spanish moss, faux or real leaves, faux or real grass, sand, or small shells

☐ 1 copy of the “Layers Over Time” Activity Sheet for each student

Materials

Teacher Prep Notes

For each student, prepare a golf ball-sized lump of Play-Doh, clay, or homemade modeling dough. (If you use homemade dough along with beans, pasta, or other foods, you'll be able to compost your creations when done.) Place dry goods in separate containers so that students can easily choose four options. Consider copying the Student Activity Sheet onto cardstock for better durability.

> ***The nation behaves well if it treats the natural resources as assets which it must turn over to the next generation increased, and not impaired, in value.***
>
> **—Theodore Roosevelt**

Background

Stratigraphy is a branch of geology that involves the study of rock layers. Earth's history is "written" in these layers. They allow paleontologists and geologists to study the relationships between the objects they find embedded/events they find recorded in stone. The law of superposition states that lower strata (layers of stone) are older than those closer to the surface. Before the development of absolute dating techniques, scientists relied on this principle to determine the relative ages of the materials they found—a stone, bone, or artifact in a lower level of rock or soil was older than the stones, bones, or artifacts in the layers above.

Today, we're also able to use the absolute dating technique of radiometric dating. Radiometric dating gives a more exact age for an object based on the amount of naturally occurring radioactive material it contains. (After their formation, radioactive materials decay at a constant rate. The ratio between the remaining radioactive material and the material it becomes after decaying allows scientists to determine how long decay has taken place, i.e., the age of the object.)

The national parks offer many excellent, clearly visible examples of stratification. The Grand Canyon displays evidence of stratigraphy even more obvious and spectacular than the hoodoos seen in the film. Within Grand Canyon National Park, it's possible to observe nearly 40 major layers of sedimentary rock, ranging in age from 200 million to 2 billion years.

The lower strata of the Grand Canyon walls contain remains of marine animals. This is evidence of a time, about 500 million years ago, when the area was deep underwater. Higher strata contain the remains of land animals, showing a gradual transition to a new dry land environment, about 320–270 million years ago. This sequence of fossils has allowed scientists to understand what the area looked like in the distant past and how it changed over time.

Stratigraphy helped early paleontology develop from an amateur hobby into a legitimate science. And even though techniques like radiometric dating now allow us to date materials to within 5% of their actual age, stratigraphic dating techniques remain useful. Radiometric dating requires lots of lab work and special equipment, but scientists in the field can quickly establish dates through stratigraphy. Scientists familiar with the geology of a given area can use stratigraphy to determine fairly accurate dates, and it's a useful tool for students who don't have access to a laboratory at all.

To Do

1. As a class, discuss the formation of sedimentary rocks, and the law of superposition.

Weather and geological forces like volcanoes, erosion, and deposition constantly shift and move the materials of the earth around, creating new layers on top of the old.

If new layers are constantly forming over the top of old layers (that is, forming on surface of the earth), are the layers way underground older or younger? Why?

The law of superposition describes how the deeper you go into the ground, the older the material there is. Superposition tells geologists how old rocks are in comparison to the rocks above and below them. It does not give specific dates. It is a relative dating technique.

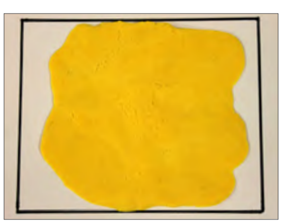
If the dinosaurs are millions of years older than humans, would we find dinosaur fossils next to human fossils? Why or why not?

2. Tell students that they are going to be creating their own section of earth with four different layers.

3. Explain to students how to create their section of earth.

Give each student a copy of the "Layers Over Time" activity sheet.

Show the students how to flatten and place the dough or clay into the box on the activity sheet.



How to spread dough into the box on the activity sheet.

Example of placement of dry, small consumable materials into the dough or clay

Students will then choose four of the dry, small, consumable materials to push into the dough or clay. They will need to place them in layers, pretending that the bottom of the box on the paper is the bottom of the earth section and the top of the box is the top of the earth section.

4. Allow time for students to create their section of the earth.

5. Once students are finished, have them leave their creations at their seats and switch places with other students.

Everyone should now be looking at another student's work.

6. First, students should write their name on the paper in front of them. On the lines below, they should record three statements about the age of the various layers. For example, "The bean layer is older than the rice layer," or "The pasta layer is the oldest."

7. Once students are done with their statements, have the students switch seats again and repeat step 6.

8. Have students go back to their original seats and discuss the following:

Besides rocks, what can you find in rock layers? (e.g., sand, water, shells, fossils, etc.)

The fossils found in a stratum can tell scientists a lot about the environment thousands and even millions of years ago.

What kinds of fossils would an archaeologist find in a desert layer? An ocean layer? A tropical forest layer?

9. Show students the ground cover materials that are available. Let the students know that these will represent the fossils of shells, grass, plant material, leaves, Spanish moss, sand, or other ground covers. Have the students choose two of these materials and then add them to two of the layers of dry, consumable materials on their dough. On their student activity sheet, they will write a description of the types of environments that may have left these "fossils" behind.

LAYERS OVER TIME

Student Activity Sheet

Student Reviewer 1 ____________________

Student Reviewer 2 ____________________

My layer story:

Taking It Further

NGSS ALIGNMENT MS-ESS1-4

Discuss with students that while relative dating, like the activity they have just done, gives geologists a lot of information about sedimentary strata, it doesn't give specific dates. Geologists must also use absolute dating in order to determine exactly how old a rock layer or fossil will be.

Radiometric dating is a form of absolute dating. Radiometric dating is used on very old rocks, like in the Grand Canyon. Radiometric dating techniques take advantage of the fact that some atoms of radioactive materials decay over time. Radioactive atoms decay by ejecting subatomic particles like protons, neutrons, electrons, and positrons. Scientists know how long it takes for certain types of atoms to decay, so based on how much of that type of atom is left in a rock, they can estimate how long ago the rock was formed.

For example, if it takes a million years for half of the radioactive atoms to decay, a one-million-year-old rock would have half the radioactive material you'd see in a newly formed rock. After another million years, it would have half of that amount, so a two-million-year-old rock would have one quarter (half of half) of the radioactive material you'd see in a newly formed rock. And so on. . .

What kinds of really old fossils would scientists want to study and know how old they are?

Why would it be helpful for scientists to find a date for the rocks in a stratum near other fossils like footprints or plant impressions?

Recommended Reading

Archaeologists Dig for Clues
Kate Duke

The Best Book of Fossils, Rocks and Minerals
Chris Pellant

Dirtmeister's Nitty Gritty Planet Earth
Steve Tomecek

LESSON 7: THROUGH THE CHAIN

Using simple materials, students will model the movement through the food chain of air, water, solar energy, and nutrients. Students will also create a model of an endangered food chain by removing an intermediate trophic level, as seen in the film.

Grade Level(s): 3–5
Lesson Length: 45 minutes

NGSS alignment: 5-LS2-1
Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

In the Film

In the late 1800s and early 1900s, a craze for hats decorated with exotic feathers wiped out 95% of Florida's shorebirds. What did the drastic decline in the Everglades' egret populations mean for the plants, animals, and overall ecosystem?

Key Words/Vocabulary

Food chain: A way to represent the flow of energy and nutrients between organisms. Each organism in the chain eats the one before it, and is eaten by the one after

Food web: A series of interconnecting food chains

Trophic level: The position an organism occupies in a food chain, from first-level producers through intermediate and top-level consumers

Producer: An organism that creates its own energy using the sun, carbon dioxide, and water; depends on nutrients from the environment

Consumer: An organism that receives energy from other organisms in order to survive. Can be an herbivore, omnivore, or carnivore

Decomposer: An organism that breaks down dead organic material—plants or animals—into nutrients

Materials (for class of 30)

☐ 100 green pipe cleaners; Cut each into 5 equal pieces, for a total of 500 2.4" lengths
☐ 100 blue pipe cleaners; Cut each into 3 equal pieces, for a total of 300 4" lengths
☐ 50 white pipe cleaners; Cut each into 2 equal pieces, for a total of 100 6" lengths
☐ 50 brown pipe cleaners
☐ 500 yellow pony beads
☐ 500 blue pony beads
☐ 500 white pony beads
☐ 2 dice
☐ 14 containers or trays for the pipe cleaners
☐ 18 containers for the pony beads
☐ 10 pie pans
☐ 2 timers or stopwatches
☐ 2 copies of "Container Labels"; Cut these apart to label the containers for the pipe cleaners, beads, and pie pans
☐ "Decomposer Job" card; cut in half

Photo shows materials for 15 students, or half the class.
The materials list assumes a class of 30 students.

Teacher Prep Notes

This lesson plan is written for a class of 30 students, and the materials list allows two groups of 15 students to play the game simultaneously.

You may need to adapt the activity according to the number of students in your class. Since students will each play the role of an organism—a producer, consumer, or decomposer—this lesson is most successful when students have already been introduced to the food chain and food chain terms. About half of the students should play the roles of plants, with decreasing numbers of students at each subsequent trophic level. At each trophic level, beads will be added or transferred to pipe cleaners to represent organisms receiving the matter they need to survive. Even in very large groups, only one student should play the role of decomposer. Refer to the room set-up diagram when placing materials.

Room Diagram

> *Plants, animals, and stars are all kept in place, bridled along appointed ways, with one another, and through the midst of one another—killing and being killed, eating and being eaten, in harmonious proportions and quantities.*
>
> —John Muir

Background

An ecosystem is a biological community of interacting organisms and their environment. Producers—usually plants—use energy from the sun and nutrients from the environment to generate their own food. Herbivores eat the plants. Predators eat herbivores. And decomposers break down wastes and dead organisms and return the energy and nutrients to the system. These organisms are connected through complex relationships. Eliminating predators, for example, can set off a chain reaction that affects an entire ecosystem by reducing habitat complexity and species diversity.

In 1832, John James Audubon visited the Everglades. He wrote, “We observed great flocks of wading birds flying overhead towards their evening roost. . .they appeared in such numbers to actually block out the light for some time.” But by 1900, the huge flocks had been hunted to near-extinction. The reason? A craze for women’s hats decorated with exotic feathers. Hunters targeted the birds during the mating and nesting season, when feathers were full and colorful, killing the parents and leaving the chicks to starve. In just one year, 1886, some five million birds were killed for their feathers. With so few birds left, feathers were worth twice their weight in gold. Fortunately for the birds, ladies’ fashion changed and feathered hats went out of style. Conservationists passed the Migratory Bird Treaty Act of 1918. Everglades National Park was established in 1947 to “conserve the natural landscape and prevent further degradation of its land, plants, and animals.”

But birds—and hatmakers—aren’t the only ones to suffer in a situation like this: hunting and habitat destruction has also pushed the Florida panther to the brink of extinction. The Florida Panther depends on the birds of the Everglades as one of its food sources. With fewer birds, the endangered panther (fewer than 200 remain in Florida) will struggle to find food, and the population may drop to the point of extinction. With an already shrinking habitat, the search for food could force the Florida Panther further into the populated areas surrounding the Everglades National Park, exposing them to the dangers posed by cars and humans. And even then, the panthers might not find a suitable substitute food source. Shrinking Everglade bird populations will also affect the organisms below them on the food chain. The Everglade’s egrets, for example, eat fish, amphibians, reptiles, and mice or other small mammals. Without egrets, there would be fewer checks on prey populations, and the ecosystem could become unbalanced. Might a big fish population eat all the water plants? Would Everglades frogs expand into other regions to outcompete local frog species or spread infectious diseases among them? Could a booming mouse population move past its current range and become a problem in human-populated areas? These are just hypothetical scenarios—the effects of an unbalanced ecosystem can be far reaching and difficult to fully predict.

To Do

1. Lead a discussion about food chains. If the white pipe cleaners represent snowy egrets, what might the other pipe cleaners represent? Ask students to notice the different sizes, and to consider what various organisms eat.

> NOTE: In this lesson plan, green pipe cleaners represent grasses, blue pipe cleaners represent fish, and brown pipe cleaners represent panthers. But the same set *could* represent bushes, mice, and alligators, or any of a variety of other producers/consumers in the egret-involved Everglades food web. If you decide to use different examples, use the backs of the provided container labels to identify the organisms.

2. Have students determine what the "plants" need in order to survive, and identify the corresponding pony beads: blue represents water, white represents air, and yellow represents the sun.

3. Give the directions for the game. Grasses need air, water, and sun in order to grow, so each green pipe cleaner should have a blue, a white, and a yellow bead. Once the grasses have "grown," they can be eaten by the fish.

Pipe cleaners will look like this once they have "eaten." Only plants will "eat" the beads. The other organisms will "eat" by taking beads from the plants, fish, or egrets.

Students should place their completed plants into the pie tin labeled "plants that have eaten." In order for the fish to survive, they need to eat two grasses. Transfer the beads: each fish pipe cleaner should now carry the six beads from two grass pipe cleaners.

Don't add new beads; just transfer them from the plants.

Put the completed fish into their pie tin. Continue up the food chain with the egret and panther; each organism needs to eat two of the organisms from the level below them.

4. Before you start the game, ask students if anything is missing from the food chain. Explain that the decomposer will roll the die every 15 seconds and follow the directions on the "Decomposer Job" card.

For example:
Roll 1 = plant or Roll 4 = Fish

Move the decomposed organisms to the pie tin labeled "Decomposed Organisms."

5. Assign students to their roles. For a class of 30 playing in two groups of 15, assign 7 plants, 4 fish, 2 egrets, 1 panther, and 1 decomposer in each group.

6. Play the game for five minutes. As students are playing, ask individual students what they're noticing about this model.

7. Stop after five minutes and have students count the organisms available at each trophic level. How many plants do you have? How many egrets and panthers? How many beads does each organism carry? How many plants do you need to support one panther? How many organisms decomposed? What happens to the organisms eaten by the decomposer?

8. Have students reset the game. This time, modify the food chain to model what happens when the hunters kill most of the egrets for their feathers. Have each student play a new role, and assign 7 plants, 4 fish, 1 egret, 1 panther, 1 decomposer, and 1 hunter in each group. Explain that the hunter will grab egrets as soon as they have all of their beads.

9. Play the game again. You should notice the plant and fish populations growing, egrets disappearing, and no panthers.

Have students discuss the following questions as a large group, as a written reflection, or in small groups:

For each consumer level, how many fish/egrets/panthers do we have? Why?
What would the fish/egrets/panthers have to do to survive?

Example responses: *The panthers didn't have enough food to survive. They would have to compete with other species for their food source. It might cause a decline in a competing predator's population.*

How would that affect other species?
How many plants do we have? Why?
What would this mean for the survival of the organisms in the chain?
Are there enough resources to support the plants and their growth?
Why is it important to protect all of the links in a food chain?
Why should humans care?

SUN	WATER	EGRET
SUN	WATER	PANTHER
SUN	PLANT	PANTHERS THAT HAVE EATEN
AIR	PLANT	FISH THAT HAVE EATEN
AIR	PLANT	EGRETS THAT HAVE EATEN
AIR	FISH	PLANTS THAT HAVE EATEN
WATER	FISH	DECOMPOSED ORGANISMS

DECOMPOSER JOB

Student activity sheet

- Roll the die every 15 seconds
- Check the chart below for who to decompose
- Take the corresponding organism from the pie tins
- Place it in your pie tin

ROLL

1 = Plant
2 = Plant
3 = Plant
4 = Fish
5 = Egret
6 = Panther

DECOMPOSER JOB

Student activity sheet

- Roll the die every 15 seconds
- Check the chart below for who to decompose
- Take the corresponding organism from the pie tins
- Place it in your pie tin

ROLL

1 = Plant
2 = Plant
3 = Plant
4 = Fish
5 = Egret
6 = Panther

Taking It Further

Graph the numbers for each round.

Math Common Core alignments:
CCSS.MATH.CONTENT.2.MD.D.10
CCSS.MATH.CONTENT.3.MD.B.3,
CCSS.MATH.CONTENT.5.MD.B.2
CCSS.MATH.CONTENT.6.RP.A.1

NGSS alignment: LS4.D
Mix black beads in with blue beads to represent water pollution. Play the game as described above. At the end of the game, discuss endangered food chains or bioaccumulation.

Pretend something happened to the population of fish. Change the number of fish in the game and observe what happens.

NGSS alignment: LS2.C
Change the size of a pie pan to allow only a certain number of a type of organism to move on. Organisms that don't fit in the pan don't survive due to limiting factors.

www.phylogame.org

Recommended Reading

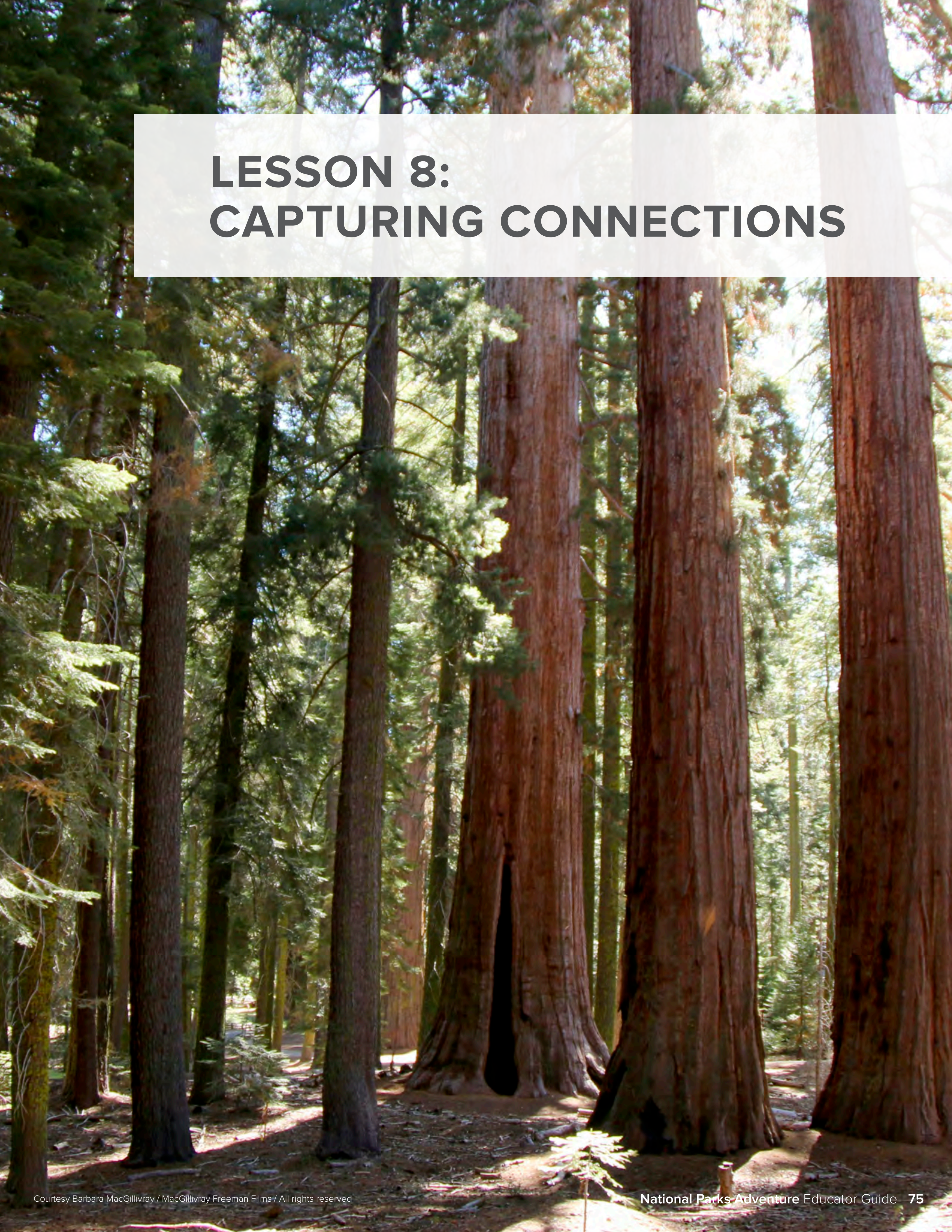
And Then There Was One: The Mysteries of Extinction
(Sierra Club Books)
Margery Facklam

What Are Food Chains and Webs?
(Science of Living Things)
Bobbie Kalman and Jacqueline Langille

One Night in the Everglades
(Long Term Ecological Research)
Laurel Larsen

What Are Food Chains & Food Webs?
(Britannica Let's Find Out Series)
Louise Spilsbury

LESSON 8: CAPTURING CONNECTIONS



Students will predict patterns of competitive, predatory, and mutually beneficial interactions between organisms living in prairie, marsh, forest, and ocean habitats, and then discover the actual interactions that exist in nature.

Grade Level(s): 6-8
Lesson Length: 45 minutes

NGSS alignment: MS-LS2-2
Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

In the Film

Farmers and ranchers consider prairie dogs pests, and have poisoned, gassed, or shot as much as 98% of the original population. But safe inside National Parks—like Devils Tower National Monument in Wyoming—prairie dogs create rich ecosystems for other animals. More than 160 species depend on prairie dogs in some way for food and shelter. Similarly, the Brooks River in Alaska's Katmai National Park teems with salmon that sustain the entire ecosystem. From the brown bears who feast on the fish during the salmon run to the mammals, birds and fish who forage on salmon eggs, some 137 species depend on the nutrients salmon provide. Using the animals of *National Parks Adventure* as examples, students will explore the relationships between organisms in the prairie, marsh, forest, and ocean.

Key Words/Vocabulary

Symbiotic relationship: A close relationship between two species. There are three types of symbiotic relationships: mutualism, parasitism, and commensalism

Mutualism: A symbiotic relationship in which the two species benefit from each other. An example is the the remora and shark. The remora attaches itself to the shark's body. It gets a free ride, protection from predators, and food leftovers. The remora also eats parasites off the body of the shark.

Parasitism: A symbiotic relationship in which one species benefits, and the other is harmed.

Commensalism: A symbiotic relationship in which one species benefits and the other is neither harmed nor helped.

Predator-prey: A relationship between two organisms in which one organism acts as predator and the other serves as prey. Predators hunt prey for food. Some examples include an owl catching and eating a mouse; a pack of wolves hunting a moose, and a human shooting a deer.

Materials

☐ 2 sets of Critter Card decks
(to print, choose "Short edge binding" in your printer options)
(these work best when printed on cardstock and/or laminated)

☐ 32 copies of the Student Activity Sheet
(or 1 for each student in the class)

☐ 16 copies of the Answer Key

Teacher Prep Notes

This lesson plan is designed for a class of 32 students.

Students should work in groups of four, with groups seated together either at a table or with desks pushed together. Consider copying the cards on different colored paper or cardstock to distinguish between ecosystems. Cut apart the critter cards before class. You may add an organism you have been studying, include an organism from your environment, or let students choose an organism to include.

> ***When we try to pick out anything by itself, we find it hitched to everything else in the Universe.***
>
> **—John Muir**

Background

Symbiosis is the close interaction between different species. Any type of interspecies biological interaction (parasitic, mutualistic, and/or commensalistic) can be classified as symbiotic.

A simple example of mutualistic symbiosis is the relationship between flying insects and flowers. A single bee can visit up to 5,000 flowers in one day on its quest for food (nectar and pollen). As it travels from flower to flower, the bee transfers pollen from the male part of one flower to the female part of another, resulting in fertilization and the production of seeds. Bees and flowering plants depend on each other for survival. This relationship is also at the heart of human agriculture. Fruit, vegetable, and nut farmers are almost completely dependent on bees to fertilize crops each year.

Some mutualistic relationships are less visible. For example, the bacteria in our digestive tracts can help strengthen the immune system, create essential vitamins, and produce helpful hormones. In return, the bacteria are provided with an environment in which they are protected and nourished.

To Do

1. Place students in groups of four, and give an Activity Sheet to each student. Hand out the decks of Critter Cards: two groups get the prairie set, two groups get the forest set, two groups get the marsh set, and two groups get the ocean set.

2. Each group will work together to predict the relationships that exist between the different organisms described on their Critter Cards. Have them always frame the relationships between the anchor species and others in the deck. As they make their predictions, students should fill out the Student Activity Sheet.

Example

Parasitic
I think the flea and prairie dog have a parasitic relationship because fleas eat blood and can live on prairie dogs.

3. After 5 minutes, have groups switch cards so that they have a different set of Critter Cards. They should predict the relationships as they did in step 2.

4. Repeat step 3 twice, having students make predictions for the third and fourth sets of Critter Cards.

5. Have the class count off by 8s to form new groups of 4 students each. Have all the 1s, 2s, 3s, etc., meet to discuss their predictions and answer the questions on the Student Activity Sheet.

6. Once the Student Activity Sheets are complete, give each group an Answer Key. Allow them time to review the existing relationships and compare those to their predictions.

Prairie dog

Black-footed ferret

Flea

Grasses

Burrowing owl

Brown bear

Fleas

0.05–0.15 inches long
Consumer

Fleas are wingless insects, but they can jump incredible distances relative to their body length. Their mouthparts are adapted for sucking blood.

Black-footed ferret

About 20 inches long
Consumer

Blackfooted ferrets have flexible spines and long, skinny bodies that fit through tight spaces.

Prairie dog

Stands 12–15 inches tall and weighs 2–3 pounds
Consumer

Prairie dogs are herbivores. They create communal burrows with many chambers, including nurseries, sleeping quarters, listening posts, and even toilets.

Brown bear

5–8 feet tall
Consumer

Brown bears live in forests and mountains, often near water sources. They mostly live alone, but they sometimes gather to take advantage of rich temporary food sources.

Burrowing owl

Stands 7.5–10 inches high, with a 20-inch wingspan
Consumer

Burrowing owls line their burrows with mammal dung, which attracts the beetles the owls eat.

Grasses

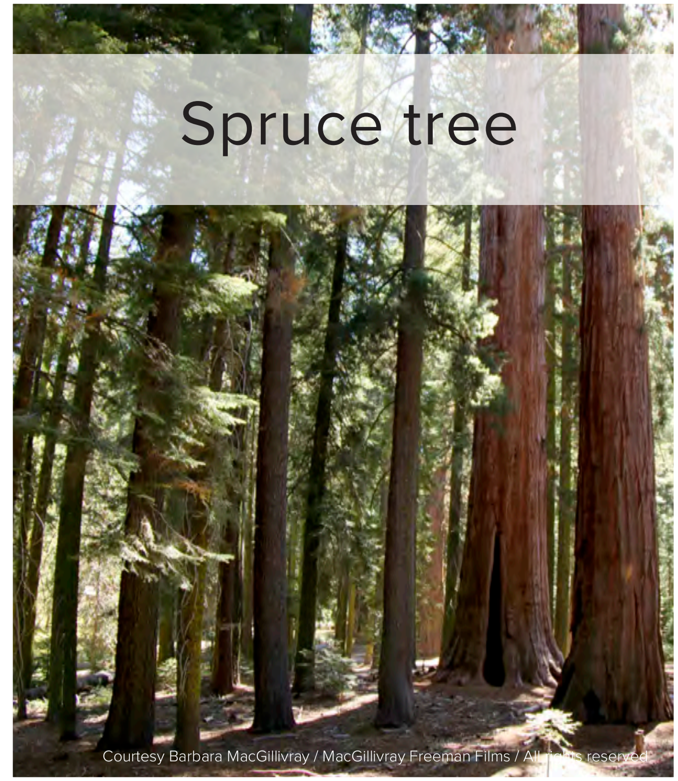
Many varieties
Producer

Grasses grow all over the world, in almost every habitat, and need water, sun, air, and nutrients to survive. Grasses need to be aerated in order to grow.

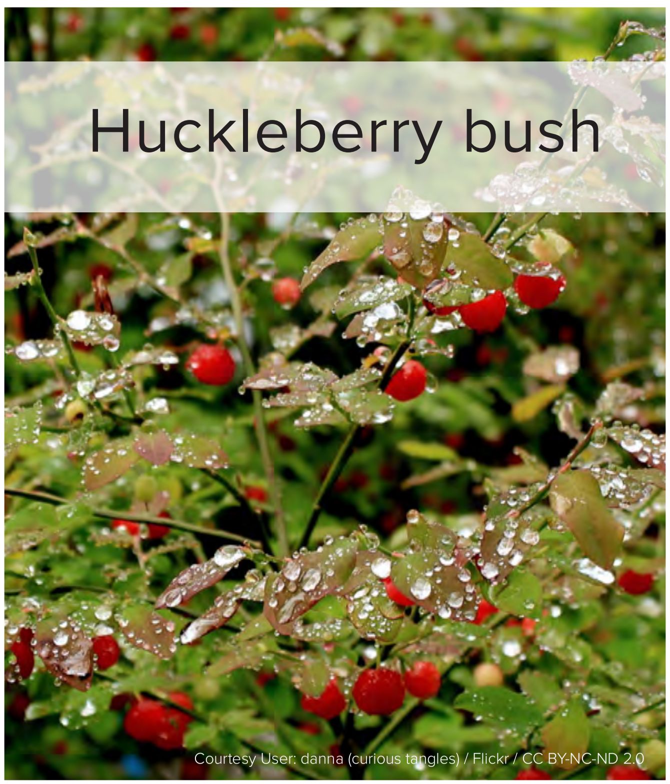
Louse

Salmon

Spruce tree



Huckleberry bush



Egret

Roundworm

Spruce tree

65–200 feet tall when mature
Producer

Spruce trees grow in the northern temperate regions of the world. They need water, sun, air, and nutrients to survive.

Salmon

About 3 feet long
Consumer

Salmon start their lives in freshwater rivers and lakes. Young salmon migrate to saltwater, where they take advantage of the ocean's vast food resources and grow. As adults, they return to freshwater to mate, deposit their eggs, and die.

Louse

0.07 inches long
Consumer

These wingless insects (plural: lice) have mouthparts adapted for eating skin fragments and hair.

Roundworm

Up to 6 inches long
Consumer

Roundworms reproduce inside the guts of wading birds, which distribute worm eggs in their poop. The worms' tunnels sometimes kill the birds.

Egret

Stands about 3 feet tall
Consumer

Snowy egrets mostly wade in the shallows, using their bills to spear fish and other aquatic animals. But they hunt insects on dry land, too. Egrets nest in trees near water.

Huckleberry bush

Berries are 0.2–0.4 inches in diameter
Producer

Huckleberries are small fruits that ripen in late summer. Inside each fruit is a seed.

Florida panther

Courtesy User: U.S. Fish and Wildlife Service Southeast Regiont / Flickr / CC-BY-2.0

Red mangrove tree

Katja Schulz / Flickr / CC-BY-2.0

Cattle

Courtesy User: Mike / Flickr / CC-BY-2.0

Tiger shark

Courtesy User: Sebastien Lafont / Flickr / CC-BY-2.0

Remora fish

Courtesy User: tobze / Flickr / CC-BY-2.0

Spiny lobster

Courtesy User: Elias Levy / Flickr / CC BY 2.0

Cattle

About 6 feet tall
Consumer

Cows are herbivores. As they graze, they scare up grasshoppers and other large insects.

Red mangrove tree

Up to 80 feet tall
Producer

These salt-tolerant trees grow along warm-water coastlines. They need water, sun, air, and nutrients to survive.

Florida panther

About 6 feet long
Consumer

Florida panthers are nocturnal and solitary. They hunt deer, rabbits, raccoons, wild hogs, armadillos, and birds. The species is endangered—only 100–160 adult panthers remain in the wild.

Spiny lobster

Up to 24 inches long
Consumer

Spiny lobsters are nocturnal. They hide in coral reefs or burrows during the day, and forage for plankton or snails, crabs, and clams at night.

Remora fish

12–35 inches long
Consumer

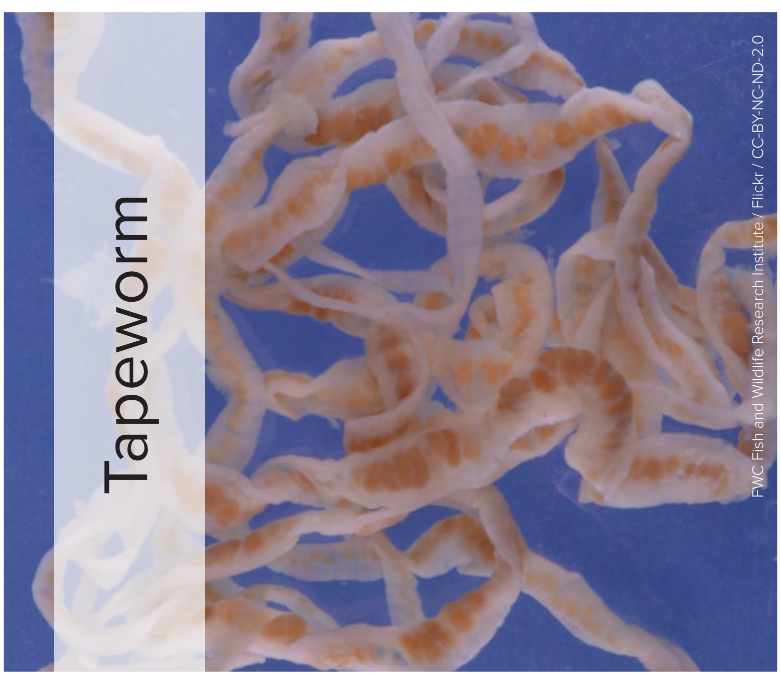
Remoras, also called suckerfish, live primarily in tropical oceans. They use their sucker discs to attach themselves to larger marine mammals.

Tiger Shark

More than 16 feet long
Consumer

Tiger sharks live in warm water and hunt alone at night. They eat almost anything they can catch, from clams, crabs, fish, and squid, to turtles, dolphins, and even other sharks.


Pilot fish
Courtesy User: Tom Weilenmann / Flickr / CC-BY-2.0


Tapeworm
FWC Fish and Wildlife Research Institute / Flickr / CC-BY-NC-ND-2.0

Pilot fish

24–28 inches long
Consumer

Pilot fish eat the leftovers of the larger animals that it swims next to.

Tapeworm

Some are <0.04 inches long; others reach 100 feet
Consumer

Tapeworms soak up nutrients from digested food.

CAPTURING CONNECTIONS

Student Activity Sheet

Directions:

Write the definitions of each relationship below. Then identify the anchor species from critter card deck and predict the relationship between the anchor species and the other species. Write the type of relationship you predict they have at the top of the box and either draw a picture or use words to represent your thinking.

Commensalism –
Mutualism –
Parasitism –
Predator-Prey –

Prairie: Prairie Dog

Black-Footed Ferret	Fleas	Grasses	Burrowing Owl

Ocean: Tiger Shark

Remora Fish	Spiny Lobster	Tapeworm	Pilot Fish

Marsh: Egret

Roundworm	Florida Panther	Red mangrove tree	Cattle

Forest: Brown Bear

Huckleberry Bush	Salmon	Spruce Tree	Louse

Talk to your group members about your predictions. Then answer the following questions.

1. What are some predictions that you agreed upon?

2. What are some predictions that were different?

3. After your discussion, which predictions would you change? Which would you keep the same?

Show that you have completed numbers 1 –3 to your teacher in order to receive the answer key. Review the answers and match them to your predictions. How'd you do? Circle your ranking on the scale below.

1 2 3 4 5 6 7 8 9 10

I didn't know any of them **I knew some of them** **I knew all of them!**

4. Why should humans be concerned about these symbiotic relationships?

5. Pretend you live in a world where the ecosystems are all mixed up—for instance, the tiger shark swims alongside a prairie dog and the black-footed ferret frolics with an egret through the forest. Using the organisms from above, but in a mixed up way, make up a mutually beneficial relationship between any 2 of the organisms. Choose each one from a different ecosystem. **Write 1–2 sentences describing the relationship and then justify the type of relationship using 1–2 sentences.**

CAPTURING CONNECTIONS

Answer Sheet

Prairie Prairie dogs have the following relationships with other organisms:

Fleas	Fleas bite prairie dogs and drink their blood	Parasitism
Black-footed ferrets	Ferrets hunt and eat prairie dogs	Predator-Prey
Grasses	Prairie dogs eat grasses, but they also aerate and fertilize the soil so new grass can grow	Mutualism
Burrowing owls	Owls make their nests in the burrows prairie dogs dig	Commensalism

Forest Brown bears have the following relationships with other organisms:

Louse	Lice bite brown bears and drink their blood	Parasitism
Salmon	Bears catch and eat salmon	Predator-Prey
Huckleberry Bush	Bears eat berries, spreading berry seeds when they poop	Mutualism
Spruce trees	Bears leave salmon scraps in the forest, which fertilizes the soil and helps spruce trees grow	Commensalism

Marsh Egrets have the following relationships with other organisms:

Florida Panthers	Florida panthers hunt and eat egrets	Predator-Prey
Cattle	Cattle scare up grasshoppers from the grass allowing egrets to eat more easily	Commensalism
Roundworms	Roundworms reproduce inside egrets, using the birds' digestive tracts to distribute their eggs	Parasitism
Red mangrove trees	Egrets build their nests in mangrove trees	Commensalism

Ocean Tiger sharks have the following relationships with other organisms:

Remora fish	Remoras attach themselves to tiger sharks, eating parasites on the sharks' bodies and scraps leftover from their meals	Mutualism
Pilot fish	Pilot fish receive protection and food from the tiger sharks they swim with	Commensalism
Spiny lobsters	Tiger sharks eat spiny lobsters	Predator-Prey
Tapeworms	Tapeworms live in tiger sharks' intestines and get nutrients directly from the sharks' food	Parasitism

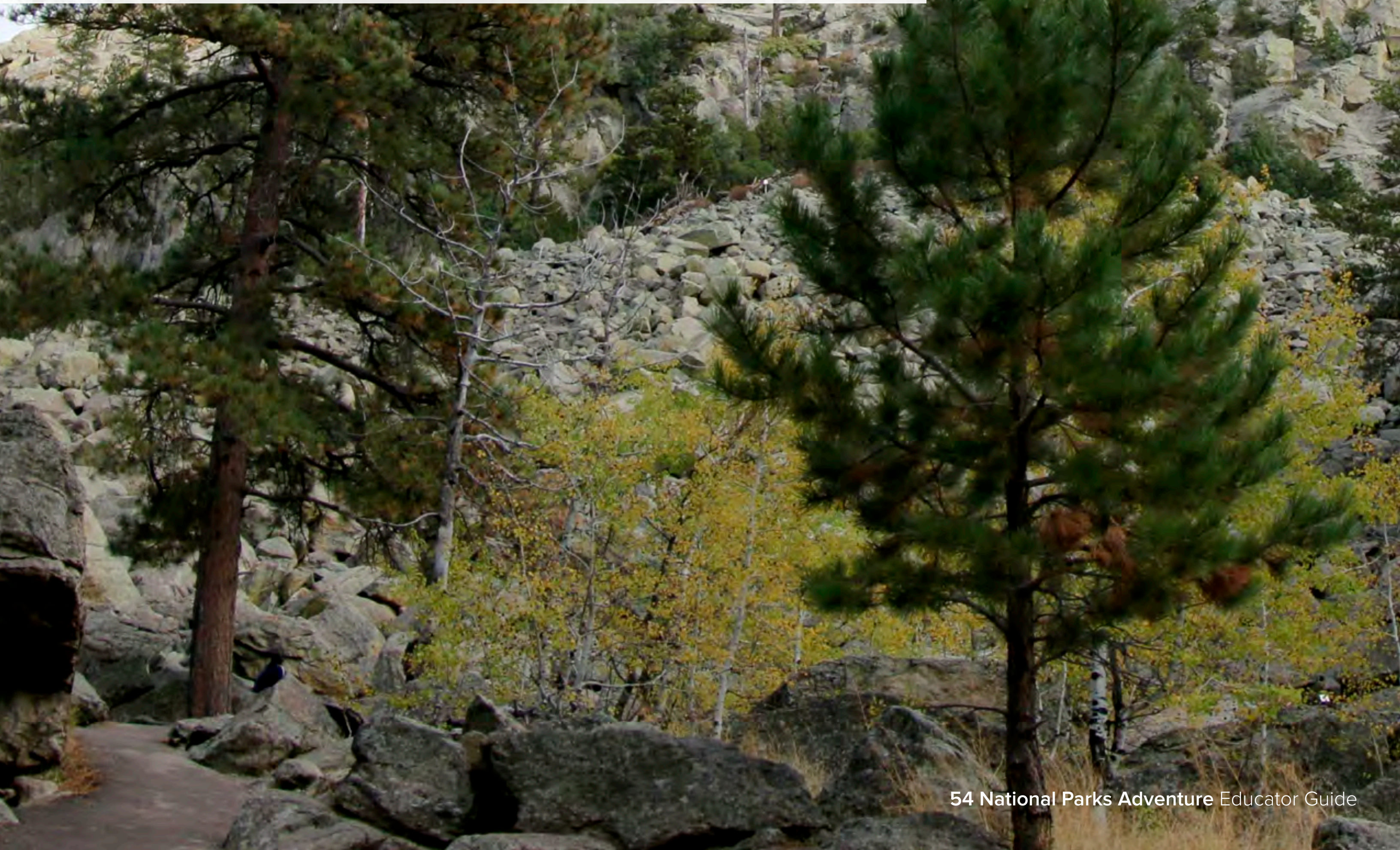
Taking It Further

NGSS alignment: MS-LS2-2
Have students create two new species of organisms and describe a symbiotic relationship that could exist.

Recommended Reading
Weird Friends: Unlikely Allies in the Animal Kingdom
Jose Aruego and Ariane Dewey (picture book)

What's Eating You?: Parasite—The Inside Story
Nicola Davies

Symbiosis (Science Concepts Second)
Alvin Silverstein, Virginia Silverstein, Laura Silverstein Nunn



LESSON 9: EXPLOSIVE VOLCANO

Students will create models to experiment with gas pressure, one of the factors that influences the violence of a volcanic eruption.

Grade Level(s): 6–8

Lesson Length: 45 minutes

NGSS alignment: MS-ESS2-2

Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

In the Film

Volcanic activity is responsible for iconic features of several national parks seen in the film. Devils Tower National Monument is the heart of an ancient volcano. The surrounding sedimentary rocks have eroded over millennia, leaving only the core. Yellowstone National Park sits over the world's biggest volcanic caldera. The Grand Prismatic Spring—America's largest hot spring—and half of the geysers on the planet are in the park. Katmai National Park in Alaska surrounds stratovolcanic Mount Katmai and the Valley of Ten Thousand Smokes. The park includes 18 individual volcanoes, 7 of which have been active since 1900. How has volcanic activity shaped our national parks and monuments over millions of years?

Key Words/Vocabulary

Lava: Hot melted rock at or near the Earth's surface

Volcano: Mountain made by repeated eruptions of lava and cinders

Gas pressure: The force exerted by a gas on its container

Cinders: Rock fragments formed when lava cools quickly, trapping gas bubbles in place

Materials

per group of 2 students unless otherwise noted

☐ 1 plastic water or soda bottle, 16 or 20 ounce, with label removed

☐ 1 meter stick

☐ 1 100 ml graduated cylinder

☐ 1 piece of plastic wrap, 10 cm x 10 cm

☐ 1 rubber band

☐ 1 toothpick

☐ 6 antacid tablets, such as Alka-Seltzer

☐ 1 funnel

☐ 5 ml dish soap

☐ 1 pipette

☐ Tap or warm water, enough to fill the plastic bottle for three trials

☐ 1 plastic container, such as a lab bin or deep-sided tray (to collect the liquid that will erupt from the model and contain the mess)

☐ "The Explosive Volcano" lab sheet, one for each student

☐ Safety goggles (class set)

☐ Towels and/or sponges to clean up

Materials for each group

Teacher Prep Notes

Cut one piece of plastic wrap for each group. Groups should be able to re-use the wrap for multiple trials by using a different section of the wrap for each trial. Additional plastic wrap should be on hand in case groups need more. Remind the students to wear their safety goggles for the entire time they're working at the lab station, even while cleaning up.

> ***The shocks and out-bursts of earthquakes, volcanoes, geysers, storms, the pounding of waves, the uprush of sap in plants, each and all tell the orderly love-beats of Nature's heart.***
>
> **—Theodore Roosevelt**

Background

Volcanoes formed many of the national parks' most prominent features. These volcanoes stretch from the middle of the Pacific Ocean, to the mountains of Alaska, all the way inland to Wyoming.

Bubbling up from the floor of the Pacific Ocean, huge volcanoes created the islands of Hawaii. Still active today, Hawaii's volcanoes are protected within Hawaii Volcanoes National Park on the island of Hawaii and Haleakala National Park on Maui.

Far to the north, the Aleutian Range in Alaska is one of the most concentrated areas of volcanoes on Earth. On the northern end of the range sits Mount Katmai, the center of Katmai National Park. Mount Katmai is a large stratovolcano or composite volcano, a conical volcano formed by solidified layers of hardened lava, ash, and other volcanic materials. Katmai has been sleeping since 1912, when a massive, 60-hour-long eruption blew the top of the volcano, forming a three-mile-wide volcanic crater (or caldera) at its peak. A mountaintop lake now fills this caldera. The 1912 eruption also created the Valley of Ten Thousand Smokes, an area inside the park that spewed steam for years after the event.

The National Parks System's most famous caldera, however, is far from the Pacific Rim and other areas normally associated with heavy volcanic activity. Slumbering in Yellowstone National Park in Wyoming is a supervolcano. Supervolcanoes exist where magma rises from deep inside the planet but is unable to break through the earth's crust. Supervolcanoes are capable of producing eruptions that could expel more than 240 cubic miles of volcanic material. Yellowstone is currently dormant, but the heat from this volcanic system powers the park's iconic geysers and the Grand Prismatic Spring (which we see in the film.)

The national parks hold many other examples of volcanic activity as well. Devils Tower National Monument, seen in the film, is the exposed core of a long vanished volcano. In Oregon, the eruption of Mount Mazama nearly 8,000 years ago created Crater Lake National Park's eponymous lake.

In Lassen Volcanic National Park in northern California, visitors can observe volcanic activity in boiling mud pits and hot springs. Mount Rainier, in Washington's Mount Rainier National Park, is a stratovolcano like Katmai, and the tallest mountain in the Cascade Range. Rainier is an active volcano, and while there is no evidence that it will erupt soon, the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) considers it to be one of the most dangerous volcanoes in the world because of its proximity to highly populated areas.

The film describes these volcanic areas as "the beating heart of our planet," and the active volcanoes of the national parks truly do hold the power to shape the earth and its life.

To Do

1. Introduce the activity to students by having students brainstorm what volcanos or evidence of volcanos that they saw in the film

> **some examples include:** Yellowstone, Devil's Tower, rock formations in Utah

2. Discuss the differences that exist between these different examples as well as other volcanic examples. Do some have more violent eruptions than others?

3. Tell students that they will be completing a lab today that will help them better understand what effect the amount of gas has on the violence of a volcanic eruption.

4. Students should now read through "The Explosive Volcano" lab sheet before beginning the experiment. Consider reading the directions aloud as students follow along or popcorn read.

> **Hint:** in step 7 where students poke a hole in the plastic, be sure they poke a hole straight down. If the hole is poked sideways at all, the "volcano" will erupt.

5. Students conduct their experiment by following the directions on the lab sheet.

6. As students are working, ask the groups the following questions:

   What is happening in the bottle that makes the eruption occur?

   How is this model like a volcano?

   How is it not like a volcano?

   Are all volcanos shaped this way?

   What are some other variables that you could test?

THE EXPLOSIVE VOLCANO

Student Activity Sheet

Purpose Question

How does the amount of gas dissolved in lava affect the type of volcanic eruption that occurs?

What's the independent variable? ______________________________

What's the dependent variable? ______________________________

Hypothesis *("If..., then...")*: ______________________________

Materials

- ☐ 1 water bottle
- ☐ 1 lab bin/deep sided tray
- ☐ 1 meter stick
- ☐ 1 graduated cylinder
- ☐ plastic wrap piece
- ☐ 1 toothpick
- ☐ 1 rubber band
- ☐ 3 packs of Alka-Seltzer (2 tabs in each pack)
- ☐ funnel
- ☐ dish soap (in a container with a pipette)
- ☐ goggles
- ☐ water
- ☐ towels/sponges for clean up (for the class: a mop!)

Procedure

1. Put on your safety goggles.

2. Measure the height of your water bottle to the nearest tenth of a centimeter and record.

3. Fill the water bottle with water, roughly up to the start of the neck of the bottle. You must leave a small gap of air at the top of the bottle.

4. Use the pipette to add a squirt of dish soap (about 1ml).

5. Break ONE Alka-Seltzer tablet in half (it won't fit into the bottle if you don't break it up a little).

6. Put the whole tablet into the water bottle and QUICKLY cover the top with the plastic wrap, securing the wrap in place with the rubber band. You don't want any air to get out. Leave the bottle in the plastic container/lab bin/deep-sided tray.

7. Wait 5–10 seconds. Then one group member should use the toothpick to carefully poke a tiny hole in the top of the plastic wrap. At the same time, another person should hold the meter stick next to the bottle to measure the height of the eruption (if any). Make your measurement to the nearest whole centimeter and record. Try to contain all of the liquid from the eruption in the plastic container/lab bin/deep-sided tray.

8. Let the eruption continue until it stops foaming out of the bottle. Measure your eruption by pouring the liquid you collected in your bin/tray into the graduated cylinder. Use the funnel so you don't accidentally spill any. Record the amount of liquid that came out of the bottle.

10. Find the difference between the height of the bottle and the highest height the eruption reached to determine the height of the eruption. Record this difference in the data table for trial 1.

11. Repeat steps 3–10 using TWO tablets.

12. Repeat steps 3–10 using THREE tablets.

Data:
Height of the bottle: ________________cm

	Height of the eruption (cm) (subtract the height of the bottle from the total eruption height)	**Amount of escaped liquid (ml)**
Trial 1 (ONE tablet)		
Trial 2 (TWO tablets)		
Trial 3 (THREE tablets)		

Analysis

Using full sentences, write a paragraph that discusses:

What happened when you put the Alka-Seltzer tablet into the water?
What happened to the amount of gas produced as you added more tablets to the water?
Which trial had the greatest eruption height?
Which trial had the most amount of escaped liquid?
What caused the liquid to be forced out of the bottle?
Summarize the effect that the amount of gas has on the violence of a volcanic eruption.

Taking It Further

Discuss lava viscosity, another factor of violence of a volcanic eruption.

Fill small clear jars with the following liquids: water, molasses, hair gel, shampoo, honey, syrup, rubbing alcohol, or other liquids with different viscosities.

Students should carefully rotate each jar of liquid and observe and record the way the liquid flows.

Discussion question: If you were to rate each liquid's viscosity on a scale from 1 to 5 with 1 being very low (easy to flow) and 5 being very high (hard to flow) what number would you give each liquid?

Discussion question: How would the liquid's viscosity affect the violence of a volcanic eruption?

Draw connections between the viscosity of lava with the types of volcanic cones they can create (shield, stratovolcano, cinder cone, etc.)

Recommended Reading

What's So Hot About Volcanoes? (What's So Cool About Geology?)
Wendell Duffield

A Weird and Wild Beauty: The Story of Yellowstone, the World's First National Park
Erin Peabody

Volcanoes
Seymour Simon

Earthquakes and Volcanoes
Lin Sutherland

LESSON 10:
HOW HIGH CAN YOU CLIMB SAFELY?

Students will examine the factors affecting the dropping force in a lead climber fall.

Grade Level(s): 6–8

Lesson Length: 60 minutes

NGSS alignment: MS-PS2-2

Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

In the Film

In the film, famous mountaineer Conrad Anker, his stepson Max, and Rachel make a series of climbs: Devils Tower, Arches National Park, and Pictured Rocks National Lakeshore. At the Three Penguins formation in Arches National Park, we see Conrad lead climbing and placing anchors to protect himself, Max, and Rachel in the event of a fall. Conrad's anchors are spring-loaded cams that he pushes into cracks in the rock face. Any downward load—such as a falling climber—converts the pulling force along the stem of the cam into outward pressure on the rock, locking the cam in place.

Key Words/Vocabulary

Lead climber: On a climbing team, the lead climber climbs up first and sets anchors for the other climbers

Belay: Someone or something to which a rope is secured

Crack climbing: Climbing technique in which the climber follows a crack in the rock face

Cam: Spring-loaded camming device anchored to the mountain, attached to the climber, and used to stop a fall

Crampon: Plate with spikes attached to aid in ice climbing

Ice axe: Pointed hand tool used by ice climbers

Materials (per group of three)

☐ 3 rulers, wooden or metal

☐ 3 meter sticks

☐ Duct tape (6–8 feet)

☐ Masking tape (optional)

☐ 20 ounce (591 mL) plastic bottle

☐ Four pieces of dental floss,
each 2 meters in length

☐ Beaker (at least 250 mL)

☐ Scissors

☐ Copies of Student Activity Sheet, one per student

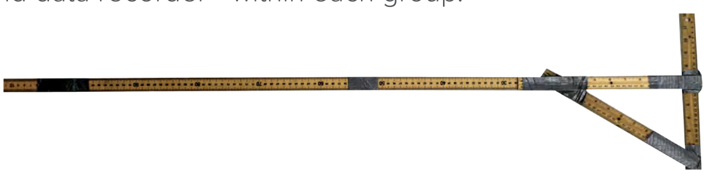
Materials to make dropping apparatus and student materials

Teacher Prep Notes

Our tests indicate that Target brand unwaxed dental floss breaks at the following volumes and drop heights:

Volume	Drop Height
150 mL	Did not break at any height
200 mL	2 m
250 mL	1.5 m
300 mL	1.5 m
500 mL	0.5 m

Different brands of dental floss will differ in their exact strength, but will display a similar pattern of volume and drop height. If time permits, determine this breaking point before class. This test will also establish the resiliency of the apparatus. Although this activity is written in a teacher-led fashion, consider allowing students to determine the drop heights and masses. Consider assigning roles—such as holder, dropper, and data recorder—within each group.



You must also prepare the dropping apparatus.

1. Lay 2 meter sticks end-to-end with their metric sides facing up. Secure the meter sticks to one another with duct tape.

2. Reinforce the two meter sticks with a third. Lay the additional meter stick on top of the taped meter sticks with its ends at the 50 cm marks. Tape it in place with strips in the middle and at each end.

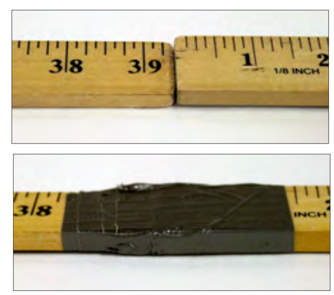
3. Using 3 rulers, build the triangle top:

   With the first ruler, extend the top meter stick by 3 cm. Secure the ruler to the meter stick with duct tape.

   Hold the second ruler so it's perpendicular to the meter sticks, and slip it under the extension you just made so it rests on the lip created by the end of the top meter stick. Duct tape it in place.

   Connect the right end of the perpendicular ruler to the extension ruler/meter stick with a third ruler, creating a triangle. Duct tape the ends, making sure the duct tape at the bottom wraps around both the angled ruler that completes the triangle and the extension-ruler/meter stick sandwich.

Optional: Some important numbers might be obscured by the duct tape. On the meter stick, use masking tape to indicate 50, 100, and 150 centimeters from the floor.



Two meter sticks end-to-end and duct taped in the middle

Third meter stick attached to the first two meter sticks

Triangle top

Background

The earliest documented ascent of Devils Tower was made in 1893, when two local ranchers reached the top by drilling into the rock and inserting pieces of wood to build a ladder. This type of climbing is both destructive to the rock and very dangerous. But techniques and equipment have improved over the last 120 years. Cams, hexes, nuts, ice screws, and other removable safety devices have all been developed to minimize damage to climbing surfaces and maximize climber safety. The film shows Conrad, Max, and Rachel climbing at several locations within National Parks. Conrad—the most experienced of the three—is the lead climber, and responsible for the others' safety.

Climbing became a recreational activity in the 1600s. The earliest climbers relied on ropes made of natural fibers and a lot of courage. But those early ropes were heavy, weak, and thick—not great characteristics for climbers attempting to move quickly or cover long distances. In the 1900s, military interest in soldiers being able to traverse mountainous terrain spurred innovation. Nylon, invented by DuPont in 1935, made stronger, lighter, and more durable climbing ropes. But the real breakthrough came in 1953 when German rope manufacturer Eldelrid developed the first kernmantle rope—a braided nylon sheath around a nylon rope core. Kernmantle ropes are stronger, stretchier, and more durable than plain nylon ropes. And when Elderid realized that wet ropes lose up to half their strength, the company developed water-repellent kernmantle rope. This is the modern standard for climbing, and it's likely that Conrad, Max, and Rachel are using kernmantle rope.

Today's climbers use mechanical cams, steel ice axes, crampons, and other specialized equipment. But while climbing is surely much safer than it used to be, it still requires courage. *National Park Adventure* shows Conrad crack climbing Devils Tower's volcanic spines by pressing his legs and back into the side walls and slowly making his way up. The film also shows Conrad crack climbing the Three Penguins formation at Arches National Park. In that scene, Conrad is the lead climber, placing anchors while either Max or Rachel acts as his belay. Conrad sets a cam into the crack, attaches a carabiner to the cam, then clips his climbing rope through the carabiner. One end of the rope is tied to his climbing harness, while the other passes through the belay device held by Max or Rachel. If Conrad were to fall, the cams and the belay would limit his drop. At the top of Three Penguins, Conrad uses his rope as a belay for Max, then Rachel, who removes the cams as she passes them. At Pictured Rocks National Lakeshore, the group climbs a frozen waterfall using a similar technique. Conrad's friend Ryan acts as his belay from the ground while Conrad uses ice axes and crampons to climb the wall of ice. He places ice screws as anchors as he climbs. As the last climber, Rachel would have removed the ice screws, but the freezing temperatures kept her from completing the climb. Instead, she's safely lowered by the belay at the top of the waterfall.

To Do

1. Ask students to recall the climbing scenes from the film. Did the climbers use the same equipment every time? What was different? What was the same?

2. Explain lead climbing to students.

> A lead climber starts with no anchors in the mountain. He or she climbs, places a cam or screw into a crack, clips the rope to that cam or screw, and then continues climbing. He or she repeats the process over and over again, placing anchors at intervals all the way up the mountain. A single rope holds the climbers.

3. Model the experiment for your students:

Lay the apparatus down and tie one end of the dental floss to the free end of the horizontal ruler at the top. Tie the floss about 3 cm in from the end of the ruler.

Add 150 mL of water to the bottle and secure the lid.

Lay the bottle down beside the apparatus with its bottom at the 50 cm mark. Tie the other end of the floss securely under the neck of the bottle, keeping the bottom of the bottle in place at the 50 cm mark.

Now stand the apparatus up vertically, with the ruler triangle at the top and the other end touching the floor.

Have a student assist you by lifting the bottle up 100 cm off the floor. (Use the markings on the meter stick!)

Have the student drop the bottle. The rest of the class should be observing: does the dental floss break?

4. Ask students what the dental floss (climbing rope) and bottle (climber) represent. Have students continue the experiment in groups of three, testing different volumes of water and different heights.

5. Hand out the Student Activity Sheet and monitor the class as students work.

HOW HIGH CAN YOU SAFELY CLIMB?

Student Activity Sheet

Objective: To determine the height a mass held by dental floss can fall from without breaking.

Materials

☐ Dropping apparatus

☐ Dental floss, 8 meters, cut into four 2-meter lengths

☐ 20 oz (591 mL) plastic bottle

☐ 1 graduated cylinder

☐ Scissors

☐ Beaker

Procedure

1. Lay the apparatus down on the table. Tie one end of the dental floss securely to the horizontal ruler about 3 cm from the edge so the bottle can drop freely.

2. Add 150 mL of water to the bottle and secure the lid.

3. Tie the free end of the floss to the bottle so that it will hang at 50 cm above the ground. Adjust the knot if needed.

4. Stand the apparatus up, with the end of the bottom meter stick touching the ground. Lift the bottle to the 100 cm mark and drop it. Record whether or not the floss breaks (and any other observations) in the data table.

5. Repeat the last step at heights of 150 and 200 cm. Record your observations in the data table as before.

6. Lay down the apparatus. Cut off the old floss with the scissors and tie a new piece on as before.

7. Add 50 mL of water to the bottle to make 200 mL total and secure the lid.

8. Drop the bottle from the 100 cm, 150 cm, and 200 cm heights as before. Record your observations in the data table.

9. Lay down the apparatus. Cut off the old floss with the scissors and tie a new piece on as before.

10. Add 50 mL of water to the bottle to make 250 mL total and secure the lid.

11. Drop the bottle from the 100 cm, 150 cm, and 200 cm heights as before. Record your observations in the data table.
12. Lay down the apparatus. Cut off the old floss with the scissors and tie a new piece on as before.

13. Add 50 mL of water to the bottle to make 300 mL total and secure the lid.

14. Drop the bottle from the 100 cm, 150 cm, and 200 cm heights as before. Record your observations in the data table.

15. Below your data table, in a complete paragraph, analyze your data.

Data Table

Volume of Water	**Drop Height** (measure up from the floor)	**Did it break?**	**Notes**
150 mL	100 cm		
	150 cm		
	200 cm		
200 mL	100 cm		
	150 cm		
	200 cm		
250mL	100 cm		
	150 cm		
	200 cm		
300mL	100 cm		
	150 cm		
	200 cm		

Analysis

Use the following questions to construct a paragraph discussing your results and conclusions:

What were the results for each volume of water? (ex: With 150 mL of water, the floss broke at 100 cm)

What patterns did you see in the data?

What conclusions can you make from the patterns in the data?

If this model represented a real life climber, what recommendations would you have for them based on the data? How frequently should s/he place her/his anchors?

Taking It Further

Expand the range of the variables:
Drop the bottle in a stairwell or over a ledge to achieve greater drop heights.

Measure the mass of the bottle after each water addition, or attach multiple bottles to the floss.

Try materials with different tolerances for sudden tension, such as thread, low weight fishing line, or twine. (Stronger materials may break the apparatus.)

Mathematical analysis:
Calculate the time the bottle falls by using $\sqrt{t=2d/g}$, where d is distance and $g = 9.8\ m / s_2$

Calculate the velocity of the fall by using $v = g * t$

Engineering challenge:
NGSS Alignment: MS-ETS1
Using only dental floss, improve the strength of the floss so that it can hold a 591 mL bottle full of water falling from a 2.0 m height.

Recommended Reading
The Usborne Illustrated Dictionary of Physics
Chris Ade, Jane Wertheim, Corinne Stockley

Physics: Investigate the Forces of Nature
Jane Gardner

Climbing Anchors (How to Climb Series)
John Long and Bob Gaines

The New Way Things Work
David Macaulay

Rock Climbing (Extreme Sports)
Chris Oxlade

Additional Resources

http://NatGeoEd.org/LoveYourPark
To celebrate the 100th anniversary of the founding of the National Park Service in 2016, the National Geographic Society, with support from Subaru of America, Inc., has launched the “Find Your Park, Love Your Park” educational initiative, developed to teach fourth graders across the United States about the importance of U.S. national parks and to empower students to preserve and protect them. National Geographic has developed five free downloadable activity modules for educators, including an interactive map of all U.S. national parks, which invite kids to visit, explore and protect national parks.

http://www.nps.gov/teachers
The National Park Service has a website specifically designed to help teachers find resources to use in their classrooms. From classroom lesson plans to field trip suggestions, and field experiences to primary resources, this website has something for teachers of every grade level. Search by keyword, subject, grade level, and/or common core standard.

http://www.everykidinapark.gov
As part of President Obama’s commitment to protect our nation’s unique outdoor spaces and ensure that every American has the opportunity to visit and enjoy them, the Administration is launching the “Every Kid in a Park” initiative to provide all fourth grade students and their families with free admission to national parks and other federal lands and waters for a full year starting September 1, 2015. The pass is valid for the 2015-2016 school year and grants free entry for fourth graders and three accompanying adults (or an entire car for drive-in parks) at more than 2,000 federally managed sites. Individual fourth graders are able to get passes as well as educators for each of their students. Visit the website to get your passes and to learn more!

http://nmai.si.edu/explore/education/resources/classroom-lessons/
The National Museum of the American Indian has developed many lessons in collaboration with Native community members. Some of the lessons include: Native dolls, Native stories, expressionist art, and information about different peoples.

http://www.pbs.org/nationalparks/
The National Parks: America’s Best Idea
A film by Ken Burns

This six-episode series takes the viewer on a journey through the national parks. A PBS series, the episodes also introduce you to the everyday people that dedicated themselves to protecting the land that they loved. Ten lesson plans have been developed to compliment the series. Click on “For Educators” to get to the lesson plans and other resources.

http://education.nationalgeographic.com/
The National Geographic Educator website has many resources for educators including activities, lesson plans, ideas, and educator guides. You can filter your search by audience, grades and ages, subjects, and more.

http://education.usgs.gov/index.html
The U.S. Geological Survey has a website with many resources such as lesson plans, videos and animations, maps, and ways to get involved in citizen science.

http://SierraClub.org
Sierra Club youth programs spread the joy of the wilderness by providing safe and fun wilderness and nearby park trips for people with limited access to the outdoors.
Learn more and locate a program near you:
1) Sierra Club's Inspiring Connections Outdoors http://content.sierraclub.org/OUTINGS/ico
2) Sierra Club's Nearby Nature initiative. sierraclub.org/ourwildamerica/nearby-nature
3) Outdoors Alliance for Kids (OAK): http://outdoorsallianceforkids.org

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www.nationalparksadventure.com